Hardware Design Guide Version 2.0 for Microsoft Windows NT Server

A Reference for Designing Servers and Peripherals for the Microsoft® Windows NT® Server Operating System

Intel Corporation and Microsoft Corporation
Publication Date: July 22, 1998

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Welcome

Hardware Design Guide Version 2.0 for Windows NT Server is for engineers who build server systems, expansion cards, and peripheral devices that use the Microsoft® Windows NT® Server operating system.

This guide is co-authored by Intel Corporation and Microsoft Corporation. The requirements and recommendations in this guide indicate features that the hardware industry should consider in designing servers and peripherals for various price levels and performance levels.

This guide includes design guidelines for servers that will run any version of the Windows NT Server operating system. These guidelines address the following design issues:

- Features for basic commodity server design alternatives for small office/home office (SOHO) and Enterprise servers.
- Requirements for implementing the OnNow design initiative, including those related to the Advanced Configuration and Power Interface (ACPI) specification, Plug and Play device configuration, and power management in server systems.
- Implementation of devices supported under Windows NT Server.
- Manageability features that help to reduce total cost of ownership (TCO) under Windows NT Server by providing support for maximum automation of administrative tasks with centralized control and maximum flexibility.

Important: Implementing these guidelines produces servers that deliver an enhanced user experience with the Windows NT Server operating system. These requirements are not related to the minimum, most-optimal, or best system requirements for running the Windows NT Server operating system. For information about the minimum system requirements for running Windows NT Server, see the web site at http://www.microsoft.com/ntserver/.

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How to Use This Guide

Read the first chapter for an overview, and read Chapters 2 and 3 to gain an understanding of the overall system requirements. Study the other chapters to understand details about specific device classes and issues for server hardware.

Chapter	Contents
Chapter 1: Overview of Server Design Issues	Presents overview of server classes and design issues.
Chapter 2: System Component Requirements	Presents general system requirements.
Chapter 3: Bus and Device Requirements	Presents general bus and device requirements for server systems.
Chapter 4: Networking and Communications Requirements	Defines basic feature requirements for network adapters and other related communications hardware.
Chapter 5: Storage Device Requirements	Defines requirements for controllers, hard drives, tape drives, CD drives, and related devices.
Chapter 6: Physical Design and Hardware Security Requirements	Defines requirements for physical design and hardware security, such as requirements for connectors, case and component locks, and so on.
Chapter 7: Reliability, Availability, and Serviceability Requirements	Provides design guidelines related to ease of use and ease of maintenance issues.
Appendix A: Server Requirements Checklist	Provides a summary checklist of requirements defined in these guidelines.
Glossary	Defines technical terms and acronyms related to hardware and the Windows NT operating system.

As co-authors of this design guide, Intel and Microsoft provide clarification and interpretation of the requirements and recommendations in this document. Please send questions or requests for clarification by e-mail to:

designguide@intel.com
serverdg@microsoft.com

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Conventions Used in This Guide

The following conventional terms, symbols, abbreviations, and acronyms are used throughout this guide. In addition, see the Glossary later in this guide.

Conventional Terms

Add-on devices
Devices that are traditionally added to the base server system to increase functionality, such as audio, networking, graphics, and so on. Add-on devices fall into two categories: devices built onto the system board set and devices on expansion cards added to the system through a system-board connector such as Peripheral Component Interconnect (PCI).

Intel Architecture
Refers to computers based on 64-bit and 32-bit microprocessors that use the Intel Architecture instruction set, such as Intel® Pentium®, Intel Pentium with MMX™ technology, Pentium Pro, Pentium II, Pentium II Xeon™, or compatible processors. MMX technology refers to Intel's media-enhancement technology that includes new instructions added to the Intel Architecture instruction set.

DEC Alpha
Refers to Windows NT-compatible computers based on reduced instruction set computing (RISC) architecture.

System devices
Also *on-board devices.* Refers to devices on the system board set such as interrupt controllers, keyboard controller, real-time clock, direct memory access (DMA) page registers, DMA controllers, memory controllers, floppy disk controller (FDC), AT-Attachment (ATA) ports, serial and parallel ports, PCI bridges, and so on. In today's servers, these devices are typically integrated with the supporting chip set.

Windows NT or **Windows NT Server**
Refers to the Microsoft Windows NT Server version 5.0 operating system, including any add-on capabilities and any later versions of the operating system.

For a list of acronyms and definitions of technical terms, see the Glossary later in this guide.

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Required vs. Recommended Features in This Guide

The system requirements defined in this publication provide guidelines for designing servers that deliver an enhanced user experience when implemented with Windows NT Server. These design requirements are not the basic system requirements for running the Windows NT Server operating system. In this guide, hardware features are described as **Required, Recommended,** or **Optional** as follows:

- **Required**. These basic hardware features must be implemented in order for hardware to qualify as being in compliance with *Hardware Design Guide Version 2.0 for Windows NT Server* requirements.
- **Recommended.** These features add functionality supported by the Windows NT operating system. Recommended features take advantage of the native capabilities of hardware device drivers included with the operating system, usually without imposing major cost increases.

  Notice that for compliance testing, if a recommended feature is implemented, it must meet the requirements for that feature that are defined in this guide. Some recommended features could become requirements in the future.
- **Optional.** These features are neither required nor recommended, but if the feature is implemented in a system, it must meet the specified requirements to be in compliance with these guidelines. These features are not likely to become requirements in the future.

In this guide, the following terms are used in regard to the requirements:

- **Must:** Required
- **Should:** Recommended

Note: It is recognized that original equipment manufacturers (OEMs) supply systems with specific feature requirements to corporations, where customers integrate the desired solution on site. For example, a customer could specify a minimum configuration without disk drives.

Systems designed for specific corporate customers are exempt from related minimum requirements defined in this guide. Such exemptions are noted in this document. However, for compliance testing of these requirements, the system must include at least the minimum required components.

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Requirements by Server Class and Operating System Product

Requirements for three different Windows NT operating system products and three server classes are designated in these guidelines. The operating system products include:

- Microsoft Windows NT Server
- Microsoft Windows NT Server/Enterprise Edition
- Microsoft BackOffice® Small Business Server

The server classes in this guide are the same as in Version 1.0: Basic Server, Enterprise Server, and SOHO Server. (For more information, see Chapter 1, "Overview of Server Design Issues.") For ease of use in this guide, Basic, SOHO, and Enterprise class requirements are all defined together in the main body of the document, rather than in separate chapters.

Any class of server can run any server operating system product. Furthermore, there are no direct relationships that define which operating system product can or should run on each specific class of server. However, server platforms might need to meet additional requirements to meet the goals of a specific server class or to be a good target platform for a specific operating system.

The following examples show the format for differentiating server class-specific or operating system-specific requirements in this guideline. The first example is the simplest, where the requirement (or recommendation) applies to all classes of servers and all operating systems.

Ex.1. System and components support dates beyond 2000

Required

The BIOS, real time clock, CMOS, and the system as a whole must work correctly for dates from now to past the year 2000.

The second, more complex example presents specific requirements for different server classes and operating system products. The server types are defined in the left column, and the column headings designate specific operating system products.

Ex. 2. System includes intelligent RAID controller

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
SOHO:	*Optional*	*Required*	*Optional*
Enterprise:	*Required*	*Required*	*Required*

An intelligent RAID controller provides the benefit of reduced demands on the host processor or processors….

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References and Resources

The following represents some of the information resources, services, and tools available to help build hardware optimized to meet the requirements defined in this guide. This section also lists technical references for the specifications cited in this guide.

Server Design Information from Intel and Microsoft

Additional information relating to server hardware design is available from Intel Corporation at:

http://www.intel.com/procs/servers/
http://developer.intel.com/solutions/platfms/server.htm
E-mail: designguide@intel.com

Additional information about related hardware design guide issues and Windows NT Server hardware is available from the Microsoft web sites at:

http://www.microsoft.com/hwdev/
http://www.microsoft.com/ntserver/

Hardware Design Guide Compliance and Testing Programs

A specific hardware model is compatible with Windows NT if it has a Windows NT device driver designed to interact with that hardware model, and if Windows NT and that driver interoperate with the hardware in a stable manner.

Hardware Compatibility Tests (HCTs). Microsoft evaluates hardware compatibility using the Windows NT HCTs, which are run to test the interaction between device drivers and hardware. These tests issue the full range of commands available to applications and operating system software, and they stress hardware beyond the level of most real-world situations. The Windows NT HCT team runs the tests and reports results to the manufacturer. You can obtain a Windows NT HCT kit from the Windows Hardware Quality Labs (WHQL) web site at http://www.microsoft.com/hwtest/testkits/.

Hardware Compatibility List (HCL). Hardware that passes the HCTs is eligible to be included on the Windows NT HCL, available to customers by way of the World Wide Web and other sources. The HCL helps interested parties identify hardware and software that has been verified to run on Windows NT Server.

WHQL administers the hardware compliance testing programs at Microsoft. Hardware developers whose products pass the WHQL testing program receive a detailed report about how the system runs Windows NT Server based on the results of the testing. Hardware that passes testing is included on the Windows HCL at http://www.microsoft.com/hwtest/hcl/.

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Compliance Dates. Typically, these hardware design requirements go into effect on July 1, 1999, and are applicable to servers that are designed and built after this document's initial publication date. Compliance testing for some requirements may begin later because of the time required for technology changes to become widely available. For information about actual compliance testing dates for specific requirements, or about any of the hardware testing programs at Microsoft, contact WHQL:

Windows Hardware Quality Labs
Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399 USA

http://www.microsoft.com/hwtest/
E-mail: whqlinfo@microsoft.com
Fax: (425) 703-3872

Information Resources and Technical References

Information Resources

Common Information Model (CIM)
http://www.dmtf.org/work/cim.html

Desktop Management Task Force (DMTF)
http://www.dmtf.org

Intel developer information
http://developer.intel.com

Microsoft hardware developer information
http://www.microsoft.com/hwdev/

Microsoft Developer Network (MSDN) Professional membership
Phone: (800) 759-5474
Outside North America: (510) 275-0763
Fax: (510) 275-0762
http://www.microsoft.com/msdn/

Microsoft Windows Hardware Quality Labs (WHQL)
whqlinfo@microsoft.com
http://www.microsoft.com/hwtest/

Technical References

1997 Version of National ISDN Basic Rate Interface Terminal Equipment Generic Guidelines, Document Number SR-3888
http://www.bellcore.com

Advanced Configuration and Power Interface Specification, Version 1.0
http://www.teleport.com/~acpi/

Advanced RISC Computing Multiprocessor Standard Specification, Revision 1.0, May 4, 1992
http://www.microsoft.com/hwdev/specs/

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An Interoperable End-to-End Broadband Service Architecture over ADSL System
http://www.microsoft.com/hwdev/publicnet/ (Version 3.0 or later)

AT Attachment 2 [X3T9.2 948D] and other ATA standards
AT Attachment 3 [X3T10 2008D] standard
ATA/ATAPI-4 Standard
ATA Packet Interface for CD-ROM, SFF 8020i
ATAPI Removable Media BIOS Specification (ARMD)
Global Engineering Documents
Fax: (303) 397-2740
Phone: (800) 854-7179 (U.S.)
(613) 237-4250 (Canada)
(303) 792-2181 (Outside North America)

ATM User-Network Interface Specification, Version 3.1
Prentice Hall, 1995; ISBN 0-13-393828-X
http://www.atmforum.com

Desktop Management Interface Specification, Version 2.0
DMI Compliance Guidelines, Version 1.0
http://www.dmtf.org/tech/specs.html

Device Class Power Management Specifications
http://www.microsoft.com/hwdev/onnow.htm

El Torito—Bootable CD-ROM Format Specification, Version 1.0
Compaq, Intel, Phoenix BIOS Boot Specification, Version 1.01
http://www.ptltd.com/techs/specs.html

European Telecommunications Standards Institute (ETSI) or Global System for Mobile (GSM) standards
Phone: +33-92 94 42 00
FAX: +33-93 65 47 16
E-mail: secretariat@etsi.fr

Fibre Channel Association
http://www.amdahl.com/ext/carp/fca/fca.html

I_2O (Intelligent I/O) Architecture Specification, Version 1.5
http://www.intel.com/design/iio/i2osig.htm
http://www.i2osig.org (special interest group)

IBM Personal System/2 Common Interfaces, Part No. S84F-9809
IBM Personal System/2 Mouse Technical Reference, Part No. S68X-2229
International Business Machines Corporation
IBM Customer Publications Support: (800) 879-275
Or contact an IBM sales representative

IEEE 1394 Standards
Telephone: (800) 949-4333
Fax: (410) 259-5045
Released Standards: Global Engineering Documents

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Information Technology Enhanced BIOS Services for Disk Drives [T13-1226DT]
ftp://fission.dt.wdc.com/pub/standards/x3t13/project/

ITU Communications Standards
Phone: (41) (22) 730-6141
Fax: (41) (22) 730-5194
E-mail: sales@itu.ch

Interoperability Specification for ICCs and Personal Computer Systems
http://www.smartcardsys.com

MCNS Documents
http://www.cablemodem.org

Media Status Notification, Version 1.03
http://www.microsoft.com/hwdev/respec/

Microsoft Platform SDK and Windows NT 5.0 DDK, including Network Driver Interface Specification (NDIS) 5.0 documentation
Provided through MSDN Professional membership;
http://www.microsoft.com/msdn/

Microsoft Windows Hardware Compatibility List (HCL)
http://www.microsoft.com/hwtest/hcl/

MMC-2 Multi-Media Command Set-2 standard
ftp://ftp.symbios.com/pub/standard/io/t10/drafts/mmc2/mmc*xxx*.pdf

Modem Developers Kit (MDK)
http://www.microsoft.com/hwdev/modem/

Multiprocessor Specification, Version 1.4
http://developer.intel.com

Multisession Compact Disc Specification
Enhanced Music CD Specification, Version 1.0
Philips Consumer Electronics B.V.
Coordination Office Optical−Magnetic Media Systems
Building SWA-109, PO Box 80002
5600 JB Eindhoven, The Netherlands
Fax: (31) (40) 732113

Network PC System Design Guidelines, Version 1.0b
http://www.microsoft.com/hwdev/netpc.htm

NTMS Programmers Guide
http://www.highground.com/ntmsmain.htm

Open Host Controller Interface (OpenHCI) Specification, published by Compaq, Microsoft, and National Semiconductor
http://www.microsoft.com/hwdev/respec/

PCI Bus Power Management Interface Specification, Revision 1.0
PCI Local Bus Specification, Revision 2.1 (PCI 2.1)
http://www.pcisig.com

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Plug and Play specifications
http://www.microsoft.com/hwdev/respec/

QIC 157, Revision D
Quarter-Inch Cartridge (QIC) Drive Standards
ftp://fission.dt.wdc.com/pub/standards/QIC/QIC157

Unimodem Diagnostics Command Reference Specification
Unimodem ID Command Reference Specification
http://www.microsoft.com/hwdev/respec/

Universal HCI (UHCI) Specification, published by Intel
http://developer.intel.com/design/usb/

Universal Serial Bus, Version 1.0
Universal Serial Bus PC Legacy Compatibility Specification, Version 0.9
Universal Serial Bus (USB) device class specifications
http://www.usb.org

Web-Based Enterprise Management (WBEM) information
http://wbem.freerange.com
http://www.microsoft.com/management/wbem/

Windows management instrumentation and Win32® Extensions schema
http://www.microsoft.com/management/wbem/
http://www.microsoft.com/hwdev/wmi/

Acknowledgments

Microsoft and Intel would like to acknowledge the special contributions of the following companies to this document:

Compaq Computer Corporation
Dell Computer Corporation
Hewlett-Packard Company
International Business Machines Corporation
NEC Corporation
Siemens Nixdorf, Incorporated

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CHAPTER 1

Overview of Server Design Issues

This chapter is an introduction to the system classes and issues related to server hardware guidelines for systems designed to work with the Microsoft Windows NT Server 5.0 operating system. This document addresses design issues for commodity servers; in general, these servers contain up to four microprocessors and use a variety of industry standard technologies.

Introduction to Design Issues

The intent of this guide is to provide information about designing servers, hardware, and software that take best advantage of the Windows NT Server operating system.

This guide represents a collection of system definitions and requirements for bus and device design. The requirements and recommendations emphasize features and attributes of a system that can perform extremely well under Windows NT Server. These guidelines emphasize the following areas:

- **Performance.** The ideal way to specify performance capabilities would be to specify performance against specific benchmark tests. However, the available benchmark tests do not allow directly comparing systems unless tests are conducted with identical client setup and software configurations, which are not currently defined. Wherever possible, requirements in this guide are defined according to the benchmark performance goals. When reliable benchmark tests are not available, specific hardware configurations are defined for servers so they achieve the performance capabilities necessary to meet the requirements defined in this guide.
- **Reliability.** To fulfill its function, the server system must run all the time, with fault-tolerance capabilities and features that smoothly replace a failed drive. High availability is an extremely important feature for all servers, although this feature can be manifested differently according to how the server is used. However, certain baseline goals are desirable for each class of server, so various elements of these requirements address reliability and high-availability needs for servers.

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- **Robustness and capacity.** For many server applications, good scalability and serviceability become extremely important. This guide specifies some requirements related to components, such as RAM and processor capabilities, to address robustness issues. Additional requirements or recommendations provide for expansion capabilities in the server system.
- **Ease of use and ease of maintenance.** Various requirements seek to address issues related to ease of use and ease of maintenance—two factors that strongly affect the TCO for servers.
- **Security.** Some requirements ensure security of user data or access to system components.

When working to meet these requirements and when choosing to support additional hardware design recommendations, the designer must continually weigh cost versus performance. In defining these guidelines, extra attention has been given to this concern.

Intel and Microsoft are dedicated to strategic industry relationships that deepen and strengthen support for evolving the platform. Both companies work with industry groups to define standards for new technologies. In support of this evolution of server platforms, Microsoft has become involved in the following efforts:

- Designing operating system support for new bus and device classes to ensure that new technologies can quickly reach a broad market.
- Enhancing the Windows NT Server operating system to make it easy for both hardware and software developers to exploit operating system capabilities.
- Offering the HCL and other programs to help customers identify hardware and software designs that take advantage of the Windows NT Server operating system.

The system design requirements defined in this guide support a synergy among server hardware, the Microsoft Windows NT Server operating system, and Win32-based software. These requirements for systems and components are based on the following goals:

- System platforms, buses, and devices meet industry standards and specifications for each bus type and device class.
- Systems and devices meet minimum performance requirements.
- Systems and devices meet ease-of-use and physical design guidelines.
- Systems and devices are supported by device drivers that follow guidelines defined in the Windows NT 5.0 DDK for behavior, installation, and removal.
- Systems and devices support Plug and Play compatibility and OnNow power management for configuring and managing all system components under the Windows NT Server 5.0 operating system.

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Server Classes and Operating System Editions

Servers perform a huge variety of tasks and combinations of tasks, resulting in many configurations. To specify requirements in a meaningful way, this guide first defines a basic set of requirements for a generic (or basic) server platform. This guide then provides additional recommendations and requirements for the server usage models described here:

- **Basic server.** This server can be used in any environment. This server is described by a set of requirements and recommendations that seek to define a well-rounded, general-purpose server platform used solely as a server. Such a server can be used in small businesses or for a variety of uses in larger businesses, ranging from departmental use to clustered applications in the enterprise. Administration can be local or remote.

  This server's baseline capabilities include high availability, serviceability, scalability, ease of use, and ease of administration. This platform and its requirements are used as a basis for other types of servers defined by this guideline.

- **Small office/home office (SOHO) server.** Although it can be used in any environment, this server platform has features that increase its ease of use and deployment in small businesses, which usually do not have great experience using and deploying server systems. This general-purpose platform handles file, print, and client-server application requirements. This server must have a broad set of attributes to handle all typical server tasks in a limited environment. Quick recovery is required, because downtime will immediately impact the small office's ability to conduct business.

  The system must be easy to set up and manage from a remote location, such as the headquarters for a value-added retailer (VAR), or directly by the server owner, who have little or no computer knowledge. To increase ease of use and availability, the system should be capable of exploiting the reliability features of Windows NT, such as disk mirroring and clustering. The system should have low entry costs and low recurring costs, because cost is often a driving issue in SOHO environments.

  The SOHO server has additional requirements driven by the usage and deployment model for this platform. The SOHO server could also serve as a client workstation, while simultaneously performing its normal role as a server. This dual usage imposes additional requirements for power management and configuration.

- **Enterprise server.** This server can also be used in any environment, but is frequently deployed as the building block for a large organization where it often performs special-purpose tasks, such as handling and routing e-mail, or storing financial data. Because this server is an indispensable part of the organization, it must be highly available. Therefore, software and hardware mechanisms must be in place to eliminate unplanned downtime.

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The Microsoft Windows NT Server operating system is available in three editions:

- Windows NT Server: Provides integrated networking, application, and communications services plus Microsoft Internet Information Server, Index Server, message queuing, and transaction processing.
- Windows NT Server/Enterprise Edition: Extends the scalability, interoperability, availability, and manageability of Windows NT Server to provide solutions for large, mission-critical servers in the enterprise.
- Microsoft BackOffice Small Business Server: Provides small businesses with essential tools, including file and printer sharing, business-critical applications, e-mail and scheduling, and support for Internet and communications services such as Internet, remote access, and fax.

Designing Systems for Windows NT Server

The requirements and recommendations in this guide are defined in relation to classes of server systems and components used with the Microsoft Windows NT Server operating system.

Windows NT Server is a preemptive, multitasking operating system that includes security and networking services as fundamental components of the base operating system. Windows NT Server runs on both complex instruction set computing (CISC) and RISC processors. Windows NT Server also supports high-performance computing by providing kernel support for computers that have symmetric multiprocessor configurations.

Under Windows NT Server 5.0, new Plug and Play capabilities and OnNow power management capabilities are made available for ACPI-compliant server systems. Other major hardware initiatives for Windows NT 5.0 include the following:

- Support for new bus and device classes, including USB, IEEE 1394, Human Interface Device (HID) class, and Fibre Channel
- Support for Microsoft Cluster Server
- Online volume management, hierarchical storage management (HSM), Windows NT Media Services (NTMS), and improvements in backup and recovery support
- Support for Web-Based Enterprise Management (WBEM) and Windows Management Instrumentation (WMI) as part of the Zero Administration initiative for Windows, reducing hardware ownership costs
- Support for I_2O architecture
- Support for Windows NT Server running on 64-bit platforms

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For information about Windows NT Server 5.0 features and capabilities, see http://www.microsoft.com/ntserver/.

Preparing for ACPI and OnNow Design

Windows NT Server 5.0 will include support for ACPI, which supports operating system–based power management and Plug and Play system–configuration capabilities. This guide introduces some of the system and device capabilities required for hardware that is Plug and Play-compliant when used with Windows NT 5.0.

The goal of the OnNow design initiative is to ensure that all system components work together to enable robust and reliable system configuration and power management. The operating system and applications work together intelligently to deliver effective power management. All devices connected to the system or added by the user participate in the device power management scheme.

The OnNow design initiative means new requirements for the operating system, applications, device drivers, and hardware in order to deliver transparent power management and improved integration of components. The changes include:

- Enhanced core operating system functionality for power management.
- Windows Driver Model (WDM), which supports power management and Plug and Play, and provides a common set of I/O services and binary-compatible device drivers among Windows® 98 and Windows NT for targeted device classes (audio, input, video, and still imaging) and bus classes (USB and IEEE 1394).
- A new system interface for operating system–directed power management and Plug and Play. The ACPI design also provides future extensibility and improved system integration.
- Device and bus hardware power management interfaces and state definitions.
- An application architecture that allows applications to integrate into power management of the system.

The ACPI specification defines a flexible and abstract hardware interface that enables a wide variety of server systems to implement power and thermal management functions while meeting the cost and feature requirements of the target market. ACPI also provides device configuration and generic system-event mechanisms for Plug and Play, unifying the power management interface with the Plug and Play interface.

The ACPI implementation is independent of the processor architecture and enables the operating system to direct power management throughout the system.

For more information about ACPI and the OnNow design initiative, see the OnNow web site at http://www.microsoft.com/hwdev/onnow.htm.

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Microprocessor Architecture

This section summarizes design issues related to processors used on systems that meet the requirements in this guide.

Windows NT is designed to run on platforms that use Intel486® (with uniprocessor support only), Intel Pentium, Intel Pentium with MMX technology, Pentium Pro, Pentium II, or compatible processors that use the Intel Architecture instruction set. When Windows NT is running on an Intel Architecture processor, a virtual-86 processor mode allows direct execution of most instructions in MS-DOS®–based applications. In virtual-x86 mode, a few instructions, such as I/O, must be emulated to virtualize the hardware.

Windows NT can also run on computers with RISC processors, such as DEC Alpha. When Windows NT is running on a RISC processor, hardware support is not available for executing such MS-DOS instructions, so Windows NT emulates all these instructions and provides a virtual hardware environment using the Virtual Device Manager (VDM). The Windows NT VDM also supports ROM BIOS interrupt services, MS-DOS Interrupt 21 services, and virtual hardware for devices using virtual device drivers.

Advanced RISC computing (ARC) refers to a RISC computer architecture standard associated with the Advanced Computing Environment (ACE) consortium. For ACE-compliant platforms, the system firmware must support bootstrap loading and execution as an abstracted set of ARC routines and ARC devices.

For both kinds of platforms, a hardware abstraction layer (HAL) interfaces between the hardware and the system. Device drivers for certain types of devices create an alias between the names of their device objects and the corresponding ARC device name by calling the appropriate application programming interface (API).

For some devices in Windows NT, there are no differences in the requirements for supporting any microprocessor platform. For example, a network adapter driver calls DMA-related functions of the NDIS interface library for DMA operations between the host and the network adapter. These functions support maximized portability so the driver can run on both Intel Architecture and DEC Alpha systems.

However, some differences in microprocessor platform requirements must be addressed in the Windows NT device driver. For example:

- Phase 1 of Windows NT system startup is specific to the particular microprocessor platform. On Intel Architecture servers, the hardware boot ROM loads a boot sector, which in turn loads the NTLDR. For RISC platforms, the firmware loads necessary ARC drivers, acquires hardware configuration data, and then loads the OSLOADER.

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- Phase 2 of Windows NT system startup sets up memory, captures hardware configuration data, constructs a description of the hardware in memory, and puts a pointer to this description into the loader block.
- On Intel Architecture servers running Windows NT, there are two kinds of video miniport drivers: VGA-compatible miniports and miniports that rely on having the system-supplied VGA miniport driver or other VGA-compatible Super VGA (SVGA) miniport driver loaded concurrently.

  On RISC platforms, miniport drivers rely on the system-supplied VGA support, if necessary. For all RISC platforms running Windows NT, video miniport drivers need not supply any special support for full-screen MS-DOS–based applications. Instead, video miniport drivers must be set up to configure themselves in the registry.

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CHAPTER 2

System Component Requirements

This chapter presents requirements and recommendations that apply to the whole server system, including key components such as memory and power management. They apply to commodity servers that run the Microsoft Windows NT Server operating system, including platforms based on Intel Architecture and DEC Alpha processors.

Tips for selecting high-performance system components. For manufacturers who want to select high-performance components for server systems, the following are design features to look for when selecting components that will improve memory performance:

- Implement PCI controllers as peer bridges to improve I/O bandwidth.
- Support fast, large, expandable memory.
- Support the largest Level 2 (L2) cache possible for systems with Pentium or compatible processors.

Note: The system requirements defined in this publication provide guidelines for designing servers and peripherals that deliver an enhanced user experience when implemented with Windows NT Server. These requirements are not the basic system requirements for running the Windows NT Server operating system.

General Component Requirements

This section lists requirements and recommendations for system components such as memory and power management.

1. All operating system–controlled hardware complies with these guidelines and is listed on the Windows NT HCL

Required

All hardware included in the server system that is to be controlled by the operating system must meet the guidelines defined in this guide and must be included on the Windows NT HCL. The server system itself must pass the tests provided by Microsoft to qualify for the Windows NT HCL.

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Components that are not managed or controlled by the operating system must properly reserve resources using ACPI 1.0 methods to avoid conflicts with other devices in the system that are visible to, managed, and configured by the operating system.

Components included with the system or embedded on the system board (network adapter, video, SCSI, and so on) must meet two criteria for testing:

- Pass the Windows NT HCT for the specific system being tested.
- Have drivers provided by the vendor or use drivers included with Windows NT for the system being tested.

Systems available in complete server configurations from the manufacturer must also be tested in those configurations, as follows:

- If a system is available in an extremely basic configuration, it will be tested with industry-standard add-on options.
- If a system is available completely configured as a server, it will be tested in that hardware configuration (and alternate configurations as shipped by the manufacturer).
- The system must include all configuration utilities required to configure components in the system for Windows NT Server.

Systems provided for testing must be production level, which means that no prototypes will be accepted for testing. Peripheral devices provided with a system must also meet any additional requirements specified in this guide. Notice, however, that a listing on the HCL does not necessarily qualify a device for inclusion in a system defined by these guidelines.

Recommended: For servers running Windows NT Server/Enterprise Edition, version 5.0, all device drivers in the system should have Digital Signatures and should pass the enhanced testing requirements of the driver signing program. For information, see http://www.microsoft.com/hwdev/desinit/digupwiz.htm.

2. System and components support dates from the year 2000 and beyond

Required

The BIOS, real-time clock, CMOS, and the system as a whole must work correctly for dates from now to past the year 2000.

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System Microprocessor Requirements

This section summarizes processor requirements for server systems.

Note: It is recognized that OEMs supply systems with specific feature requirements to corporations, which can include providing servers that do not include any processors pre-installed before shipping. However, for testing purposes, the system must include the minimum required components.

3. System processor capabilities meet performance requirements for each server class

Required

For all systems, whether based on Intel Architecture processors or DEC Alpha processors, the processor must be Windows NT compatible and be listed on the Windows NT HCL. Performance requirements reflect the minimum computational capabilities and performance necessary to support the demands of Windows NT Server and server applications.

For systems based on Intel Architecture processors, the minimum performance requirement consists of the following:

- 400 MHz processor.

  For Enterprise servers, processor speeds of 450 MHz or better are recommended.

- Minimum 256K Level 2 (L2) cache or equivalent memory subsystem performance.

  For Enterprise class servers with a single processor installed, the minimum requirement for L2 cache size is 512K L2 cache or equivalent memory subsystem performance.

  All multiprocessor systems must provide the functional equivalent of a minimum of 256K L2 cache for each processor. The L2 cache cannot be shared between processors in a multiprocessor system.

  The caching requirement does not apply to processors that can achieve equivalent performance without an L2 cache. The L2 cache must be implemented as a write-back cache.

Recommendations for improving performance on systems with an L2 cache are:

- Increase cache size.
- Use L2 cache capable of running at the processor core frequency.

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4. Multiprocessor-capable systems comply with symmetric multiprocessor support specifications and meet minimum expansion requirements

Required for all systems, with Enterprise class supporting expansion to at least 4 processors

For systems in which more than one Intel Architecture processor can be installed, the system must employ those processors symmetrically and must comply with the ACPI 1.0 specification and *MultiProcessor Specification, Version 1.4* or later. Support for both MPS 1.4 and ACPI helps customers through the transition from Windows NT Server 4.0 to Windows NT Server 5.0. ACPI will eventually supercede MPS.

In addition, Advanced Programmable Interrupt Controller (APIC) support must comply with ACPI 1.0 by including the Multiple APIC Description Table (Section 5.2.8).

An ARC-compliant or ACE-compliant DEC Alpha-based system meets the requirements for multiprocessor support.

For Enterprise class servers, the system must support expansion to at least four processors.

Memory Requirements

This section defines minimum memory requirements for server systems.

Note: It is recognized that OEMs supply systems with specific feature requirements to corporations, which can include providing servers that do not include any memory pre-installed before shipping. However, for testing purposes, the system must include the minimum required components.

5. Installed system memory meets minimum requirements

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*128 MB required*	*256 MB required*	*128 MB required*
Enterprise:	*128 MB required*	*256 MB required*	*128 MB required*
SOHO:	*128 MB required*	*256 MB required*	*128 MB required*

For multiprocessor systems, 256 MB is required for each processor.

All memory visible to the operating system as system memory must be cacheable. All system memory except for 4 MB must be completely available for the system to use at boot time and cannot be locked from use by the operating system.

This minimum requirement for memory available to the operating system does not preclude applications that use dynamically allocated memory for temporary uses.

Recommended: Larger installed memory configurations, which will increase performance.

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6. System memory capacity meets minimum requirements

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*512 MB required*	*2 GB required*	*512 MB required*
Enterprise:	*512 MB required*	*4 GB required*	*512 MB required*
SOHO:	*512 MB required*	*2 GB required*	*512 MB required*

Recommended: 8 GB for Windows NT Server/Enterprise Edition.

This requirement defines minimum RAM expansion capabilities. 256 MB is required for each processor in a multiprocessor platform. All memory visible to the operating system as system memory must be cacheable.

Basic server and SOHO systems being submitted for testing with Windows NT Server/Enterprise Edition must be supplied for testing with a minimum of 2 GB of installed memory; Enterprise class systems being so tested must be submitted with a minimum of 4 GB of installed memory.

7. System memory includes ECC memory protection

Required

The system memory and cache must be protected with Error Correction Code (ECC) memory protection. All ECC RAM visible to the operating system must be cacheable. The ECC hardware must have the ability to detect at least a double-bit error in one word and to correct a single-bit error in one word, where “word” means the width in bits of the memory subsystem. A detected error that cannot be corrected must result in a system fault.

In platforms using 64-bit technology, the memory subsystem must be capable of at least 2-bit detection and a single-bit correction per word, where “word” is again defined as the width in bits of the memory subsystem.

ACPI and Power Management Requirements

This section defines the system and BIOS requirements for ACPI and power management.

8. System design meets ACPI 1.0 and related requirements

Required for all server types, with additional requirements for SOHO servers

The system board set must support the *Advanced Configuration and Power Interface Specification, Version 1.0* or later. This requirement ensures that the system correctly supports the Plug and Play and power-management functionality described in this guide.

ACPI support for all server systems must include the following required capabilities:

- **A power-management timer.** System control interrupt and necessary Status and Enable (STS/EN) bits must be provided.

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- **Support for a description table that defines the complete hierarchy for system-board devices, including host PCI bridges.** The description table must include all non-Plug and Play devices to be enumerated and all other devices for which power management or removal capabilities have been added by the system-board design.
- **Each bus and device enumerated using ACPI includes the ACPI control methods necessary to configure these devices.** This includes requirements defined in these guidelines for automatic device configuration, resource allocation, and dynamic disable capabilities.

  For information about Plug and Play support under Windows NT 5.0, see the Windows NT 5.0 DDK. Standard system devices are excluded from related requirements, as described in requirement #12, "System and device configuration meet Plug and Play requirements."
- **Thermal model and fan control, if implemented, comply with Section 12 of the ACPI 1.0 specification.** Notice also that a server that supports thermal controls must have active thermal control such as a fan and cannot use passive thermal control under normal operating circumstances.

  This requirement, however, does allow proprietary value-added features that cannot be implemented using ACPI. For example, systems are permitted to use out-of-band methods to provide cooling when the operating system is not booted.
- **Support for at least one processor power state.** This can be either C1, C2, or C3.
- **No capabilities for the end user to disable system ACPI support using CMOS or other means.** Disabling ACPI will cause boot failures when Windows NT relies on ACPI to identify and initialize system devices.

  This requirement, however, does allow proprietary value-added features that cannot be implemented using ACPI.

The following ACPI support is required for SOHO servers and recommended for other server types:

- **Power button in compliance with the ACPI 1.0 specification.** This is described in requirement #9, "Hardware design supports OnNow initiative."
- **Real-time clock alarm that supports wake-up based on a scheduled time and day of the month.** If this feature is implemented, the day-of-month feature is required under these guidelines, although it is an optional feature in the ACPI 1.0 specification. Also, if this feature is implemented, system control interrupt and necessary STS/EN bits must be provided.
- **The S5 soft-off state, as required in the ACPI 1.0 specification.** If a soft-off feature is supported, it must meet the requirements for the S5 state defined in the ACPI 1.0 specification. In addition, support for either the S1, S2, or S3 sleep state is recommended. Support for the S4 or S4BIOS states is optional.

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Support for the S3 state (Suspend to RAM), which provides the optimal user experience and power savings, is likely to become a requirement in a future version of this design guide.

- **USB host controller can wake the system.** If a USB host controller is present in the system, it must support wake-up capabilities in one of the following system states: S1 or S2. Supporting wake-up from the S3 state is recommended.

  Notice that if wake-up from the S2 or S3 state is supported, wake-up must be supported for all higher power sleep states. For example, if the controller supports wake-up from the S2 state, it must also support wakeup from the S1 state.

Note: System-board power management or configuration features implemented on a server system that are defined in the ACPI 1.0 specification must comply with ACPI 1.0, even if those features are not specific requirements or recommendations in these guidelines. This requirement, however, does allow proprietary value-added features that cannot be implemented using ACPI.

9. Hardware design supports OnNow initiative

Required for all server types, with additional requirements for SOHO servers

Elements of the OnNow design initiative ensure that the operating system and device drivers control the state of individual devices and the system board set.

All devices and drivers must support the D0 and D3 power states consistent with the definitions in the Default Class Power Management Specification and the relevant device class power management reference specification. This requirement must be implemented so that each device can successfully survive a system sleep/wake transition (device D3 to D0 transition) without requiring user intervention to restore functionality.

This requirement applies whether or not system power is removed while the computer is in an S1–S4 state. The operating system supports the S4 state without system-board support, so all devices and drivers must meet this requirement.

Notice that there is no power consumption requirement for devices in the D3 state. It is recommended, however, that devices implement the D3 state so that device power consumption is reduced to near zero, with the recognition that there is no requirement to retain any device context because it will be preserved or restored by the driver when returning to the D0 state.

It is recommended that devices and drivers support the D1, D2, or both low-power states, and that they support the defined wake-up events as designated in the relevant device class power management reference specification.

SOHO servers must, and all servers should, provide PCI, USB, and IEEE 1394 buses that support power management requirements, as defined in the related bus standards.

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OnNow features that are required for SOHO servers (and that are optional for Basic and Enterprise servers) include the following:

- **System provides one or more indicators to show whether the system is in the working or sleep state.**

  Recommended: A non-flashing, light-emitting diode (LED) sleep indicator that is a different color than the wake indicator. A slowly blinking LED indicator (less than 1 Hz) is also an acceptable implementation. This applies for S1, S2, and S3 system states.

  The nonvolatile sleep state, S4 or S4BIOS, should appear to the user as the off state (S5); therefore, all of these states should have the same indicator.

- **System provides software-controlled, ACPI-based power switch.** The system should provide an easily accessible power switch that can be controlled by software and that supports the functionality required in Section 4.7.2.2.1 of the ACPI 1.0 specification.

  The following provides implementation guidelines for the power switch:

  - The power switch can be implemented as either a power button or a sleep button. The recommended implementation is to have both. If both buttons are implemented, the sleep button should be the user's primary switch interface and must be easily distinguishable from the power button. The preferred implementation is to hide the power button.
  - The function of these buttons is determined by the operating system. The default action for the sleep button is to cause the machine to enter a sleep state. The default action for the power button is to shut down the operating system and power off the machine.

    In a single-button configuration, the button can be used for either sleep/wake transitions (G0<–>G1/S1-S4) or off/on transitions (G0<–>G2/S5), depending on user preference and the policy set in the operating system.

    In a two-button configuration that includes separate power and sleep buttons, the user interface provided by the operating system will allow only the default actions.
  - In case of a hardware or software failure that prevents normal operation of the software-controlled buttons, the switch capabilities must include an override mechanism for turning off the server.

    A 4-second override mechanism is recommended in Section 4.7.2.2.1 of the ACPI 1.0 specification. The override can be on either the power button or the sleep button in a two-button configuration, but it is recommended that the override be associated with the sleep button in order to establish an industry-standard implementation.

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An acceptable but not recommended alternative to the 4-second override is a separate hidden or recessed switch that cannot be mistaken for either the power button or the sleep button.

Notice that the override mechanism is not an alternative way for the user to turn off the server in normal operation; it is only a fail-safe function for fault conditions.

- If the power switch is provided on the keyboard, the key must be clearly labeled and must consist of a single keystroke for turning on the server, to ensure accessibility for persons with disabilities. (Two keystrokes can be used to turn off the server.)

  For information about scan codes for keyboard power switches, see http://www.microsoft.com/hwdev/desinit/scancode.htm.

- **The system power supply provides "standby" power for system wake-up events.** A minimum of 720 mA of "standby" power is required to support wake-up devices on PCI or USB when the system is in the ACPI S3, S4, or S5 state. Additional information about this requirement can be found in *Instantly Available PC System Power Delivery Requirements and Recommendations*, at http://developer.intel.com/design/power/supply98.htm.

10. System startup meets requirements for OnNow support

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Optional*	*Optional*	*Optional*
Enterprise:	*Optional*	*Optional*	*Optional*
SOHO:	*Required*	*Required*	*Required*

This feature does not apply for DEC Alpha servers, except for the initial recommendation for fast power-on self test (POST).

The intention of this recommendation is to ensure that the end user is not presented with unnecessary visual displays and to ensure that access to error information remains available using a hot key.

The following support is suggested:

- **BIOS supports fast POST.** The system should be available to the user as quickly as possible. Although a specific time limit is not established, the basic recommendation is that power on to the bootstrap loader should occur within 5 seconds, plus hard-disk ready time, option ROMs, and time required for memory subsystem initialization and error correction code (ECC).

  The following are recommended ways to reduce processing overhead to make system boot time as fast as possible:

  - No video memory test and limited test for DRAM size.
  - No tests for serial or parallel ports.
  - No floppy disk test or media check (boot from hard disk only).

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- No tests for hard disk controller or drive type (if the system does not include swappable drives).

Fast POST mode for BIOS can be disabled by the user for troubleshooting.

- **Resume from sleep state (S1–S3) to operating system handoff should occur within 500 ms.** This recommendation does not apply to the S4 state. For all other sleep states, the time to operating system handoff means when the processor starts running (first instruction) until the BIOS jumps to the Waking Vector in the ACPI firmware control structure table, as described in Section 5.2.6 in the ACPI 1.0 specification.
- **Minimal startup display.** System startup should draw the end user's attention only when errors occur or when user action is needed.

  The default configuration should allow a beep during the boot process only in case of an error, and the only screen display should be the OEM splash screen, which can include information such as copyright notices. By default, the system should be configured so the screen display does not show memory counts, device status, and so on. The display should present a "clean" BIOS startup so that the end user is not presented with cryptic and unnecessary information.

  However, the system start-up process can include the following:

  - A blank start-up screen.
  - A hot-key override to display screen messages for troubleshooting or to display user-definable CMOS settings.
  - Text-based, end-user action messages. Examples are: messages to display the setup hot key, the system help hot key, password entry, network log-on for remote booting, and so on.
  - Manufacturer branding messages.
  - A CMOS option to turn the clean start-up screen off and on.

Recommended for SOHO servers: Compliance with *Simple Boot Flag Specification, Version 1.0* or later. This enables the BIOS to boot quickly when the last boot was successful and to perform diagnostics only if a problem occurred on the previous boot.

Startup Support Requirements

This section defines the BIOS and other requirements to support system startup.

11. System BIOS meets boot support requirements

Required

This requirement does not apply for DEC Alpha servers. Notice that the Extended System Configuration Data (ESCD) calling interface is not supported by Windows NT 5.0.

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The requirements for boot support include the following:

- **Support for unique system ID structure.** The unique system ID structure is described in "Attachment B: Preboot Execution Environment" of *Network PC System Design Guidelines, Version 1.0b* or later.

  In addition, the unique system ID must be provided to the user in printed form, for assistance in environments where it could be used as part of pre-staging systems. This mechanism is left up to the system manufacturer, but suggested means include posting the unique system ID on the system chassis or case, or printed on the shipping carton.

- **Support for preboot execution environment.** If a server provides support for network adapters that provide remote boot capabilities using DHCP and TFTP, the server must also provide support for preboot execution environment as described in "Attachment B: Preboot Execution Environment" of *Network PC System Design Guidelines, Version 1.0b* or later.

- **Implementation of security, such as a preboot password.** This is provided to protect enable and disable capabilities for hardware components before the operating system boots. At a minimum, User and Administrator levels of password protection must be provided in the BIOS. This capability prevents end users from accidentally or purposefully circumventing operating system-level security and control as applied by an administrator.

- **BIOS boot support for CD drives.** If a server includes a CD drive, the system BIOS or option ROM must support the No Emulation mode in *El Torito—Bootable CD-ROM Format Specification, Version 1.0,* by IBM and Phoenix Technologies Ltd., or an equivalent method that supports the Windows NT CD-ROM installation process.

- **BIOS boot support for network adapter.** BIOS supports booting the system from the network, with a mechanism for setting the order of precedence for boot devices. If a server provides support for BIOS boot from a network adapter, the system BIOS must comply with the requirements defined in Sections 3 and 4 (as they apply to Plug and Play devices) of the *Compaq, Intel, Phoenix BIOS Boot Specification, Version 1.01*, which describes the requirements for Initial Program Load (IPL) devices.

  The system must allow all boot devices to be configured according to order of precedence for boot. This mechanism must clearly show how the system will order boot devices when end users are making configuration choices. For example, in a system that permits booting from floppy drive, hard drive, CD or DVD drive, and network adapter, it must be clear to the end user how to set a boot order that favors a specific device such as the CD drive.

  In addition, for any system that includes a network adapter capable of PXE-based remote boot, a key sequence must be provided to allow the user to force a boot initiated from the network adapter, either directly or via a pop-up screen. This key sequence must be enabled by default. Configuration of this feature may be provided through a CMOS configuration setting. When this

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feature is enabled, the boot display must indicate the key sequence that will invoke the pop-up screen that would allow a network boot. This display must appear for a duration sufficient to be read by users, but must not lengthen the overall time needed to boot the machine.

This feature must be implemented in accordance with Appendix C of the *Compaq, Intel, Phoenix BIOS Boot Specification, Version 1.01*. Note that this feature is a *Hardware Design Guide Version 2.0 for Windows NT Server* requirement, although it is optional in the *BIOS Boot Specification*.

For consistent user experience across all system brands and types, it is suggested that system and BIOS manufacturers standardize on the F12 key to perform this actions. It is expected that F12 or another standard key sequence will become a requirement in a future version of this design guide.

- **BIOS boot support for USB keyboards and hubs.** For a server that includes a USB keyboard as the only keyboard in the system, the system BIOS must provide boot support for USB keyboards and hubs as defined in *Universal Serial Bus PC Legacy Compatibility Specification, Version 0.9* or later.

  The BIOS must also support the keyboard if attached to a hub. This support must provide the ability for the user to enter the system's BIOS SETUP program and provide enough functionality to get USB-aware versions of Windows NT Server installed and booted.

- **Implementation of BIOS updates.** System administrators must be able to upgrade BIOS ROMs to a new image. The following methods can be used to meet this requirement:

  - The remote new system setup mechanism that will be downloaded and executed at boot time.
  - Normal file access and execution methods when the system is fully booted into the normal operating system environment.

  Recommended:

  - If option ROMs are provided, they should also be capable of being updated.
  - Implement a mechanism to authenticate the requester of the update programming. Implement a mechanism to validate that the program arrived intact after download.

- **System BIOS support for console redirection of a serial port.** This capability provides support during system startup for debugging and troubleshooting activities. The BIOS must configure at least one serial port to use either 2F8h or 3F8h. This allows the port to be treated as a boot device by the BIOS and is intended to be usable by components as a diagnostic port in the event that system debugging is required by either the BIOS or the operating system.

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Recommendations for boot support are:

- **System should use the E820 interface to report memory.** The E820 interface allows systems to report (and test) memory, and also allows memory to be reclaimed. Information about this interface can be found in Paragraph 2 of Section 9.3.2, "BIOS Initialization of Memory," in the ACPI 1.0 specification, which states that the E820 specification has been updated and lists the new memory range types.
- **System BIOS or option ROM provides boot support for ATAPI bootable floppy disk drive in compliance with *ATAPI Removable Media BIOS Specification (ARMD), Version 1.0* or later.** Complying with this specification provides Int 13h and Int 40h support for bootable floppy drives as the primary or secondary floppy device.

Plug and Play Requirements

This section defines the specific requirements for Plug and Play.

12. System and device configuration meet Plug and Play requirements
Required
Optional: Support for legacy Plug and Play technology.

Windows NT Server 5.0 implements complete support for Plug and Play configuration. Each bus and device provided in a server system must meet the current Plug and Play specifications related to its class, including requirements defined in Section 6 of the ACPI 1.0 specification and the clarifications published for some Plug and Play specifications. This includes requirements for automatic device configuration, resource allocation, and dynamic disable capabilities.

For information about new Plug and Play support under Windows NT 5.0, see the Windows NT 5.0 DDK.

The following are current version numbers for all Plug and Play specifications:

- *PCI Local Bus Specification, Revision 2.1*
- *Plug and Play External COM Device Specification, Version 1.0*
- *Plug and Play Industry Standard Architecture (ISA) Specification, Version 1.0a,* plus *Clarification to Plug and Play ISA Specification, Version 1.0a*
- *Plug and Play Parallel Port Device Specification, Version 1.0b*
- *Plug and Play Small Computer System Interface Specification, Version 1.0*
- *Universal Serial Bus Specification, Version 1.0*

Note: Standard system devices are excluded from the Plug and Play requirement. The system can reserve static resources for devices such as programmable interrupt controllers (PICs) 1 and 2, timer (8254-2), keyboard controller (8042),

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real-time clock, DMA page registers, and DMA controllers 1 and 2. For systems based on Intel Architecture processors, these fixed resources are located at I/O addresses under 100h and can also include a Non-Maskable Interrupt (NMI).

Also, this requirement does not apply to devices that are completely invisible to the operating system, such as out-of-band systems management devices or I_2O hidden devices; however, these devices still must properly reserve resources using ACPI methods to avoid potential conflicts.

13. Unique Plug and Play ID is provided for each system device and add-on device

Required

Each device connected to an expansion bus must be able to supply its own unique identifier, as defined in the current Plug and Play specification for the bus that it uses. The following defines the specific requirements for Plug and Play device IDs:

- Each separate function or device on the system board set must be separately enumerated. Therefore, each must provide a device identifier in the manner required for the bus it uses.
- If a device on an expansion card is enumerated by the BIOS, it must have a unique ID and its own resources according to the device-ID requirements for the bus to which the card is connected. This includes devices that are separately enumerated on multifunction cards or multifunction chips.

The following are exceptions to the requirements for a unique Plug and Play ID:

- Legacy devices attached to the ISA bus on the system board set do not have unique Plug and Play IDs—for example, serial ports, parallel ports, or PS/2-compatible port devices. The method for device identification is defined in *Plug and Play ISA Specification, Version 1.0a,* and the ACPI 1.0 specification.
- Some multifunction devices (such as Super I/O) might include devices that do not have unique Plug and Play IDs or unique PCI Subsystem IDs, but that are supported by drivers provided with the Windows NT operating system.
- A device such as a multifunction PCI device that supports a number of functions but uses only a single set of relocatable resources does not have to provide separate identifiers for each function included on the device.
- Some devices are completely invisible to or are not managed by the operating system, such as out-of-band systems management devices or I_2O system and I_2O hidden devices. Such devices are exempt from this requirement, but these devices still must properly reserve resources using ACPI methods to avoid potential conflicts.

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In addition, if an OEM uses a proprietary mechanism to assign asset or serial numbers to hardware, this information must be available to the operating system using Windows hardware instrumentation technology.

14. Option ROMs meet Plug and Play requirements

Optional

This feature does not apply for DEC Alpha servers. These recommendations apply whether the device is present on the system board set or is provided through an expansion card. Related option ROM recommendations are also defined later in this guide for specific bus classes and specific devices, such as SCSI and graphics adapters, respectively.

Option ROMs are usually located on cards used as system boot devices. During the boot process, option ROMs initialize the boot devices, which provide the primary input, primary output, and IPL device to boot the system. However, Plug and Play option ROMs can be used to supply the Plug and Play expansion header to devices other than boot devices, enabling them to initialize both devices when the system boots.

To design an option ROM with Plug and Play capabilities, follow the requirements described in the *Plug and Play BIOS Specification, Version 1.0a*, *Clarification to Plug and Play BIOS Specification, Version 1.0a*, and the *Compaq, Intel, Phoenix BIOS Boot Specification, Version 1.01*, which describe the Plug and Play expansion header and the interaction between the system BIOS and the option ROM.

15. "PNP" vendor code is used only to define a legacy device's Compatible ID

Required

All legacy devices not enumerated by the system board set interface must not use "PNP" in their vendor and device codes. The PNP vendor code is reserved for Microsoft and vendors whose hardware is specifically assigned a particular ID. Other hardware can use a PNP code only when defining a device's Compatible ID (CID) and only after first indicating the device's Hardware ID in the Plug and Play header.

Use of CIDs is recommended for devices that use device drivers provided with the Windows NT operating system, such as a standard COM port (PNP0500).

Device Bay Requirements

Device Bay is not required for servers in this version of this guideline. However, if a Device Bay-compatible bay is implemented in a server, it must comply with the requirements in this section.

Device Bay is one solution to the problem of "surprise removal" of devices, providing a mechanism that combines well-defined notification mechanisms between the hardware and software with a physical interlock mechanism to prevent removal of a device without the corresponding hardware or software

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notifications. Server vendors should use Device Bay or other mechanisms, such as captive cables or other physical restraint mechanisms, to prevent accidental or surprise removal of devices without notifying the operating system of the operation.

16. Device Bay controller and devices, if present, meet Device Bay 1.0 and other requirements

Required

If implemented in a server, Device Bay capabilities must meet the following requirements:

- The system includes a Device Bay Controller (DBC) that complies with *Device Bay Interface Specification, Version 1.0* or later. If the DBC is implemented as a USB device, it must comply with *Universal Serial Bus Device Class Definition Device Bay Controllers, Version 1.0* or later.
- The system includes one USB port and one IEEE 1394 port for each Device Bay-capable bay in the system.

Any Device Bay peripherals provided with a server must meet the following requirements:

- Device complies with *Device Bay Interface Specification, Version 1.0* or later.
- Device uses either the USB bus, IEEE 1394 bus, or both.
- If the device uses the USB bus, it must also comply with the relevant USB device class specifications.

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CHAPTER 3

Bus and Device Requirements

This chapter defines specific requirements for buses and devices provided in a Basic server system.

Tips for selecting I/O performance components. For manufacturers who want to select high-performance components for server systems, the following are design features to look for in I/O components:

- The system has minimal or no reliance on embedded ISA and no ISA slots.
- Adapter supports bus mastering.
- PCI adapter properly supports higher-level PCI commands for efficient data transfer.
- Drivers are tuned for 32-bit performance: that is, 32-bit alignments on the adapter do not interface with 16-bit alignments on odd addresses.
- All devices and controllers must be capable of being identified and configured by software through the defined bus mechanisms.

I/O Bus Requirements

This section summarizes requirements for the I/O bus, with emphasis on requirements related to the PCI bus.

17. System provides an I/O bus based on industry standard specification
Required
Currently, for most systems, this requirement is met with PCI.

18. System supports a 32-bit bus architecture
Required
For example, for PCI, the server system must support the 32-bit physical address space; PCI adapters must be capable of addressing any location in that address space.

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19. System supports a 64-bit bus architecture

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Recommended*	*Optional*
Enterprise:	*Recommended*	*Required*	*Optional*
SOHO:	*Recommended*	*Recommended*	*Optional*

For example, the server system with a 64-bit PCI bus should support the 64-bit physical address space; 64-bit PCI adapters must be able to address any location in the address space supported by the platform.

For servers with 64-bit processors or running Windows NT Server/Enterprise Edition version 5.0 or later, the system must support a 64-bit PCI bus. Additionally, support for a 66-MHz PCI bus is recommended.

20. PCI bus and devices comply with PCI 2.1 and other requirements

Required

Recommended: PCI controllers implemented as peer bridges to provide more effective bus bandwidth. Also, servers with more than 4 GB of memory should support the PCI dual address cycle (DAC) for the 64-bit physical address space. DAC support does not preclude hardware from using 32-bit addressing.

If PCI is present in the system, the PCI bus and PCI expansion connectors must meet the requirements defined in *PCI Local Bus Specification, Revision 2.1* or later (PCI 2.1), plus any additional PCI requirements in this guide. It is recommended that PCI devices, chip sets, and expansion slots support the requirements defined in the PCI 2.2 specification. The system must also support the addition of PCI bridge cards, and all PCI connectors on the system board set must be able to allow any PCI expansion card to have bus master privileges.

All server systems also must meet the PCI requirements defined in this section, which include requirements to ensure effective Plug and Play support. In particular, see the required implementation for PCI 2.1 Subsystem Vendor IDs in requirement #30, “Device IDs include PCI Subsystem IDs.”

21. System makes a best effort to provide each PCI slot and device type access to a non-shared interrupt line

Required

System designers must make a best effort to provide access to non-shared interrupt lines by meeting these conditions:

- The system design enables all PCI slots and PCI device types to obtain exclusive use of an interrupt line when exclusive access increases performance.
- Dedicated PCI interrupts must not use vectors from ISA bus interrupts.

The high-end and low-end commodity server platforms present certain design challenges. For high-end servers, PCI 2.1 taken by itself imposes a limitation for Intel Architecture-based systems because the values written to the Interrupt Line register in configuration space must correspond to IRQ numbers 0–15 of the

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standard dual 8259 configuration, or to the value 255 which means “unknown” or “no connection.” The values between 15 and 255 are reserved. This fixed connection legacy dual 8259 configuration, if examined alone, constrains Intel Architecture-based systems, even when they use sophisticated interrupt-routing hardware and APIC support. For low-end servers, some core logic offerings provide little or no interrupt-routing support, and designers implement rotating access to interrupt resources using simple wire-OR techniques, such as those illustrated in the PCI 2.1 implementation note in section 2.2.6 of the PCI 2.1 specification.

Windows NT, with its support for both MPS 1.4 and ACPI, uses mechanisms beyond the legacy methods of routing all PCI interrupts through the legacy cascaded 8259 interrupt controllers to determine proper allocation and routing of PCI bus IRQs. This Windows NT capability allows use of interrupts beyond the 0–15 range permitted by the strict reading of the current PCI 2.1 specification language for Intel Architecture systems. System designers should include sufficient interrupt resources in their systems to provide at least one dedicated interrupt per PCI function for embedded devices and one interrupt per PCI INTA# – INTD# line on a PCI slot. This will become a requirement for all servers in a future version of this guideline.

When system designers cannot provide a non-shared interrupt line to a particular PCI device or slot because of the above situations, the server system’s documentation must explain clearly to the end user of the system how interrupt resources are allocated on the platform and which devices cannot avoid sharing interrupts. System designers may provide this documentation or information as they deem most appropriate for their product. Some possible mechanisms include:

- Documenting slots according to the order in which cards should be inserted to prevent interrupt sharing for as long as possible
- Providing information on interrupt routing and sharing via system setup programs

Some instances need additional clarification to fit within the context of this guideline. At the system designer’s discretion, PCI devices can share an interrupt line under the following conditions:

- One system interrupt line can be shared by all PCI devices on an expansion card. In other words, PCI INTA# – INTD# may share the use of a single system interrupt directed to a given PCI expansion slot. This instance of line sharing applies to both expansion card designs based on PCI multifunction devices and to expansion card designs using PCI-to-PCI bridges.
- Devices can share an interrupt in a design where a system-board set has multiple instances of a given PCI device performing a specific function. For example, two embedded PCI SCSI controllers on a system board can share a single system interrupt line. A single line can be shared when the functions of the devices are very similar, such as a case where one embedded SCSI

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controller may be dedicated to “narrow” (8-bit wide) SCSI devices and the other is dedicated to “wide” (16-bit wide) SCSI devices. On the other hand, an embedded SCSI controller may not share an interrupt with an embedded network adapter on a system board, because they perform two different functions within the system and could contend for the shared interrupt in ways that will reduce overall system performance.

22. System does not contain ghost devices

Required

A computer must not include any ghost devices, which are devices that do not correctly decode the Type 1/Type 0 indicator. Such a device will appear on multiple PCI buses.

A PCI card should be visible through hardware configuration access at only one bus/device/function coordinate.

23. System uses standard method to close BAR windows on nonsubtractive decode PCI bridges

Required

PCI-to-PCI bridges must comply with the *PCI to PCI Bridge Specification, Revision 1.0*. Setting the base address register (BAR) to its maximum value and the limit register to zeroes must effectively close the I/O or memory window references in that bridge BAR.

24. PCI devices do not use the <1 MB BAR type

Required

Recommended for Enterprise class servers: Devices on a 64-bit PCI bus must take any 64-bit BAR address.

Devices must take any 32-bit BAR address.

25. PCI devices decode only their own cycles

Required

PCI devices must not decode cycles that are not their own to avoid contention on the PCI bus. Notice that this requirement does not in any way prohibit the standard interfaces provided for by the PCI cache support option discussed in PCI 2.1, which allows the use of a snooping cache coherency mechanism. Auxiliary hardware that is used to provide non-local console support is permitted within the scope of this requirement.

26. VGA-compatible devices do not use non-video I/O ports

Required

Recommended: Device includes a mode that does not require ISA VGA ports to function.

A VGA-compatible device must not use any legacy I/O ports that are not set aside for video in the PCI 2.1 specification.

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27. PCI chip sets support Ultra DMA if primary host controller uses ATA

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Required*	*Not applicable*	*Required*
Enterprise:	*Required*	*Not applicable*	*Required*
SOHO:	*Required*	*Not applicable*	*Required*

For servers that implement PCI ATA connectivity, PCI chip sets must implement DMA as defined in *ATA/ATAPI-4 Revision 17* (*ATA*-4), and implement Ultra DMA (also known as Ultra-ATA) as defined in the ATA-4 specification.

Ultra DMA is required to avoid the bottleneck created by the current 16.6 MB per second limit on ATA disk transfer. Ultra DMA also provides error checking for improved robustness over previous ATA implementations.

An exemption exists for PCI ATA-connected CD drives used solely for the purpose of software installation on a server system. Such devices cannot be used for any other purpose, including access to data by client systems. This exemption will not be allowed in the next version of these guidelines.

This requirement does not apply for servers running Windows NT Server/Enterprise Edition, which do not use ATA for primary storage.

28. Functions in a multifunction PCI device do not share writable PCI Configuration Space bits

Required

The operating system treats each function of a multifunction PCI device as an independent device. As such, there can be no sharing between functions of writable PCI Configuration Space bits (such as the Command register).

29. Devices use the PCI Configuration Space for their Plug and Play identifiers

Required

The PCI 2.1 specification describes the Configuration Space used by the system to identify and configure each device attached to the bus. The Configuration Space is made up of a 256-byte address space for each device and contains sufficient information for the system to identify the capabilities of the device. Configuration of the device is also controlled from this address space.

The Configuration Space is made up of a header region and a device-dependent region. Each Configuration Space must have a 64-byte header at offset 0. All the device registers that the device circuit uses for initialization, configuration, and catastrophic error handling must fit within the space between byte 64 and byte 255.

All other registers that the device uses during normal operation must be located in normal I/O or memory space. Unimplemented registers or reads to reserved registers must complete normally and return zero. Writes to reserved registers must complete normally, and the data must be discarded.

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All registers required by the device at interrupt time must be in I/O or memory space.

30. Device IDs include PCI Subsystem IDs

Required

The Subsystem ID (SID) and Subsystem Vendor ID (SVID) fields are required to comply with the Subsystem ID ECN to PCI 2.1 or the equivalent requirement in PCI 2.2. The Subsystem ID ECN is available to PCI SIG members on the web at http://www.pcisig.com.

The device designer is responsible for ensuring that the SID and SVID registers are implemented. The adapter designer or system-board designer who uses this device is responsible for ensuring that these registers are loaded with valid non-zero values before the operating system accesses this device.

- To be valid, the SVID must be provided by the PCI SIG.
- Values in the SID field are vendor-specific, but to be valid must be unique to a subsystem configuration. For example, if two system boards have the same graphics chip set, but one supports an internal expansion connector while the other has added functionality such as a TV output function, then each must load the SID field with a different, unique value.

Valid non-zero values in the Subsystem ID fields are necessary for the correct enumeration of the device. When the Subsystem ID fields are populated correctly for the adapter, the operating system can differentiate between adapters based on the same PCI chip.

Valid non-zero values in the Subsystem ID fields also allow the operating system to load system miniports for system-board devices, and therefore Subsystem ID fields must also be populated on system-board devices. The exceptions to this requirement are PCI-to-PCI bridges, core chip sets, and OEM-unique system board set devices for system management that are not visible to the operating system. Notice that integration of features into core chipsets, such as graphics, audio, and so on, still requires that the unique feature integrated into a core chip set must meet this requirement.

The PCI specification and these guidelines require that all PCI functions ensure that the Subsystem ID fields are loaded with valid non-zero values before the operating system accesses the function's Configuration Space registers. This is required both at initial operation system load and after any transition of the PCI bus from B3 (the unpowered state) back to B0 (the fully powered state).

For add-on cards, this requirement must be done by hardware on the card itself—for example, by way of serial EEPROM—and not by an extension BIOS or device driver. This is because the extension BIOS code or driver code is not guaranteed to run in all relevant cases, especially for system sleep transitions or dynamic bus power state transitions in which the bus becomes unpowered. Hardware methods to support this include:

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- Pin strapping at Reset
- Loading from an attached parallel or serial ROM

If a device is designed to be exclusively used on the system board, then the system-board vendor can load valid non-zero values into these registers using the system BIOS power-on self test (POST) code or ACPI control methods (_PS0 for PCI bus B3 to B0 transitions). This is because this code must always run before the operating system accesses a function's Configuration Space registers. Once the operating system has control of the system, Subsystem IDs must not be directly writeable—that is, the read-only bit must be set and valid. See also the note on Subsystem Vendor IDs related to multiple-monitor support for display devices in requirement #13, "Unique Plug and Play ID is provided for each system device and add-on device."

31. Configuration Space is correctly populated

Required

Windows NT places extra constraints on a few configuration registers. Microsoft provides a program named Pci.exe to help debug the use of the Configuration Space. This program is available at http://www.microsoft.com/hwdev/pci/.

The following items are specific requirements for the Configuration Space:

- Populate the class code register (09h) for all devices.

  Follow the base class, sub-class, and programming interface values outlined in PCI 2.1 or later.

- Devices must not fill the BARs with random values.

  See PCI 2.1 or later for the correct usage of these registers. Notice that BARs (10h, 14h, 18h, 1Ch, 20h, and 24h) should return zero if they are not used, indicating that no memory or I/O space is needed.

Registers that have specific timing or latency requirements must not be placed in PCI Configuration Space.

32. Interrupt routing is supported using ACPI

Required

The system must provide interrupt routing information using a _PRT object, as defined in Section 6.2.3 of the ACPI 1.0 specification.

33. BIOS does not configure I/O systems to share PCI interrupts

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Required*	*Recommended*

This applies to boot devices configured by the BIOS on systems that use Intel Architecture processors. The operating system should configure all other devices.

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34. BIOS configures boot device IRQ and writes to the interrupt line register

Required

This requirement does not apply for DEC Alpha servers. This requirement applies only to boot devices configured by the BIOS. All other devices should be configured by Windows NT because, after an interrupt request (IRQ) is assigned by the system BIOS, Windows NT cannot change the IRQ, even if necessary. If the BIOS assigns the IRQ and Windows needs it for another device, a sharing problem occurs.

The BIOS must configure the boot device IRQ to a PCI-based IRQ and write the IRQ into the interrupt line register 3Ch, even if the BIOS does not enable the device. This way, the operating system can still enable the device with the known IRQ at configuration time, if possible.

35. Systems that support hot swapping for any PCI device use ACPI-based methods

Required

Windows NT 5.0 supports dynamic enumeration, installation, and removal of PCI devices only if there is a supported hardware insert/remove notification mechanism. The hardware insert/remove notification mechanism must be implemented as defined in Section 5.6.3 of the ACPI 1.0 specification.

36. All 66-MHz and 64-bit PCI buses in a server system comply with PCI 2.1 and other requirements

Required

If PCI buses that are 66 MHz, 64 bit, or both are present in a server system, all devices connected to these buses must meet the requirements defined in PCI 2.1 or later.

It is recommended that 33-MHz/32-bit PCI devices and 66-MHz/64-bit PCI devices be placed on separate PCI buses to allow the best use of I/O bandwidth in a server system.

37. All PCI devices complete memory write transaction (as a target) within specified times

Required

All devices must comply with the Maximum Completion Time ECN that is approved for the PCI 2.1 specification. This requirement is also documented in the PCI 2.2 specification. Complying with this requirement ensures shorter transaction latencies on PCI, allowing more robust handling of isochronous streams in the system.

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38. All PCI components comply with PCI Bus Power Management Interface specification

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Basic Server:	*Recommended*	*Recommended*	*Recommended*
Enterprise:	*Recommended*	*Recommended*	*Recommended*
SOHO:	*Required*	*Required*	*Required*

The PCI bus, any PCI-to-PCI bridges on the bus, and all add-on capable devices on the PCI bus must comply with *PCI Bus Power Management Interface Specification, Revision 1.1* or later. This includes correct implementation of the PCI Configuration Space registers used by power management operations, and the appropriate device state (D*x*) definitions for the PCI bus, any PCI-to-PCI bridges on the bus, and all add-on-capable devices on the PCI bus. ACPI is not an acceptable alternative.

39. System provides support for 3.3Vaux if system supports S3 or S4 state

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Recommended*	*Recommended*
Enterprise:	*Recommended*	*Recommended*	*Recommended*
SOHO:	*Required*	*Required*	*Required*

System support for delivery of 3.3Vaux to the PCI bus must be capable of powering a single PCI slot with 375 mA at 3.3V and it must also be capable of powering each of the other PCI slots on the segment with 20 mA at 3.3V whenever the PCI bus is in the B3 state.

Systems must be capable of delivering 375 mA at 3.3V to all PCI slots whenever the PCI bus is in any “bus powered” state: B0, B1, or B2.

40. PCI bus power states are correctly implemented

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Recommended*	*Recommended*
Enterprise:	*Recommended*	*Recommended*	*Recommended*
SOHO:	*Required*	*Required*	*Required*

The PCI bus must be in a bus state (B*x*) no higher than the system sleeping state (S*x*). This means that if the system enters S1, the bus must be in B1, B2, or B3. If the system enters S2, the bus must be in B2 or B3, and if the system enters S3, the bus must be in B3. Of course, in S4 and S5, the system power is removed, so the bus state is B3. A PCI bus segment must not transition to the B3 state until all downstream devices have transitioned to D3.

Control of a PCI bus segment’s power is managed using the originating bus bridge for that PCI bus segment.

- For CPU-to-PCI bridges, these controls must be implemented using ACPI or the *PCI Power Management Interface Specification, Revision 1.1* or later.

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- For PCI-to-PCI bridges, these controls must be implemented in compliance with the *PCI Power Management Interface Specification, Revision 1.1.* or later.

USB Requirements

This section summarizes requirements for Universal Serial Bus. USB is not required in a server system, but if present, it must comply with these requirements.

41. All USB hardware complies with USB 1.0 specifications

Required

Recommended: USB hardware complies with *Universal Serial Bus Specification, Version 1.1* or later.

All USB hardware present on a server system must comply with the *Universal Serial Bus Specification, Version 1.0* or later

When a system has more than one host controller, each host controller must provide full bandwidth and isochronous support. Host controllers should be located on PCI to meet this requirement.

42. USB connections use USB icon

Required

The icon can be molded, printed, or affixed as a permanent sticker. Because the location and number of USB ports can vary, appropriate icons on both ports and cables are important for user ease-of-use. Therefore, USB icons are required for external cables, connecting cables, and connection ports.

Icons can be based on vendor designs, or vendors can use the recommended USB icon defined in Chapter 6 of the USB 1.1 specification as follows:

> The USB icon should be molded into the connector and also placed on the product for ease of identifying the USB port. It is recommended that the icon on the product and the one on the plug be adjacent to each other when the plug and receptacle are mated. This icon can be used for both series A and B connector schemes. On the plug, there should be a 0.635-mm rectangular recessed area around the icon such that there is a perceptible feel of the icon.

43. USB devices and drivers support maximum flexibility of hardware interface options

Required

Device and driver designs should provide maximum flexibility of interface options to allow user-preference coordination by the operating system or other resource managers. This flexibility allows graceful use of multiple simultaneous devices and applications in a dynamic environment.

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Specifically, devices and drivers:

- Must provide multiple alternate settings for each interface where any alternate setting consumes isochronous bandwidth
- Must not use isochronous bandwidth for alternate setting 0

Recommended: devices should consume bandwidth only when they are being used.

44. USB host controller complies with OpenHCI or UHCI specification

Required

The host controller must comply with the specifications for either Open Host Controller Interface (OpenHCI; published by Compaq, Microsoft, and National Semiconductor) or Universal HCI (UHCI; published by Intel). Hardware manufacturers who design to one of these specifications are not required to provide an additional device driver for their host controller under the Windows NT operating system.

Multiple OpenHCI and UHCI USB controllers are supported concurrently by the operating system.

45. System and devices comply with USB power management requirements

Required

The server system must comply with the power management requirements in the *Universal Serial Bus Specification, Version 1.0* or later. In addition, USB devices must comply with the Interface Power Management feature in the *USB Common Class Specification, Revision 1.0* or later.

46. USB devices comply with their related USB device class specifications

Required

A USB peripheral that fits into one of the USB device class definitions must comply with the related USB device class specification. USB class drivers in the operating system are implemented to support compliant devices in each particular class. Class driver extensions and WDM allow IHVs to innovate and differentiate their products while still complying with class specifications in their base operational modes.

47. USB hubs comply with the *USB Specification, Version 1.1*

Recommended

The *Universal Serial Bus Specification, Version 1.1*, defines requirements for USB hubs that cover some ambiguities in the original 1.0 specification.

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48. Bus-powered USB hubs provide ports that can be individually power switched

Required

To minimize USB power consumption requirements, bus-powered hubs must provide ports that can be individually power switched. This contributes to the goal of reducing overall system power consumption.

Other Bus Requirements

This section summarizes requirements related to other buses.

49. Any subsystems implementing I_2O comply with standards and other requirements

Required

If I_2O is implemented in a system, it must meet the requirements defined in this guide and in the *I_2O Architecture Specification, Version 1.5* or later, available from the I_2O Special Interest Group (SIG) at http://www.i2osig.org.

If I_2O is implemented on a system, the system BIOS must support I_2O devices in the system in the following cases:

- An I_2O-capable system that includes no I_2O-intelligent devices, whether provided on the system board set or as add-on devices. The system can have an installed adapter that is I_2O-ready or I_2O-compliant, and the BIOS must initialize the device as a multifunction device. The system cannot boot from this I_2O device, because the BIOS does not support initialization of I_2O bootable device.
- An I_2O-ready system that has some sort of intelligence on the system board set or on an add-on adapter that enables sending and receiving messages, as defined in the I_2O specification. This intelligence can be an off-the-shelf processor, an application-specific integrated circuit (ASIC) when it is on the system board set, or it can be included as an add-on adapter. In these cases, the system BIOS must support initializing and configuring the device, including support for multifunction PCI. Initialization and configuration of a PCI device does not imply that the system BIOS supports compliant I_2O initialization of boot devices or that the system can boot from an I_2O device.
- An I_2O-compliant system that includes support for initializing and booting from I_2O devices, whether provided on the system board set or as add-on devices. The system as a whole must be able to pass I_2O compliance testing with Windows NT 5.0.

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50. System does not include ISA expansion slots

Required

No ISA expansion slots are allowed in servers designed to comply with these guidelines. The benefits of an ISA-free system include improved performance, easier and more stable system configuration, and lower support costs.

Out-of-band systems management devices that can be implemented in an ISA slot are the only case where an ISA slot can be present in a server. These exemptions provide a transition period for these specific technologies as they migrate to deterministic bus designs. It is anticipated that these exemptions will not be present in future versions of these guidelines.

51. System does not include embedded ISA network adapters, storage controllers, or graphics adapters

Required

The benefits of an ISA-free system include improved performance, easier and more stable system configuration, and lower support costs.

52. System does not include ISA expansion devices

Required

An ISA expansion device in this context is defined as being an expansion adapter or device installed in an ISA slot.

No ISA expansion devices are allowed, with specific exemptions for out-of-band systems management devices that can be implemented in an ISA slot; this is the only case where an ISA slot can be present in a server. These exemptions provide a transition period for these specific technologies as they migrate to deterministic bus designs. It is anticipated that these exemptions will not be present in future versions of these guidelines.

53. System includes APIC support

Required

This requirement does not apply for DEC Alpha servers.

The server must include APIC support that complies with ACPI 1.0, implemented by including the Multiple APIC Description Table (ACPI Section 5.2.8). Features such as targeted interrupts, broadcast interrupts, and prior-owner interrupts must be supported. Intel Architecture processor implementations can use the Intel APIC component.

Implementation of APIC support on server systems provides a greater number of IRQ resources, even within traditional server architectures.

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Device Requirements

This section summarizes requirements for the system devices and peripherals provided with server systems.

Note: It is recognized that administrators might not want a keyboard, mouse, or monitor attached to working servers. However, these devices are typically required at least for installation of the operating system.

54. Device driver and installation meet *Hardware Design Guide* requirements

Required

Each device must have drivers for the Windows NT operating system. The manufacturer does not need to supply a driver if the device passes compliance testing using a driver provided with the operating system.

If the manufacturer supplies drivers, the device drivers and installation requirements include the following:

- **All devices and drivers pass compliance testing for these guidelines.** Each device included in a server system must comply with the requirements defined in this section and must have supporting 32-bit device drivers for the CPU platform and operating system. The installation and loading of a driver must not reduce or eliminate functionality of other devices installed on the system. The following are also required:
  - Every driver (or minidriver) must support Plug and Play and power management I/O request packets (IRPs).
  - Real-mode or 16-bit protected-mode components must not be provided to operate under Windows NT. Only 32-bit protected-mode components are installed on systems with 32-bit processors.
  - Any device with WDM-based operating system support must have a manufacturer-supplied WDM minidriver.
  - All devices in systems with 64-bit processors must have 64-bit Windows NT-compatible drivers.
- **All configuration settings are stored in the registry.** The driver must not use INI files for configuration settings. The driver must also include correct provider, version, and copyright entries. This information is displayed in the user interface.
- **Files have correct identifiers and are stored in the correct locations.** The correct minidriver or any other manufacturer-supplied files specified in the device's INF must be installed in the correct location.

  For manufacturer-provided files, the vendor must *not* be identified as Microsoft; all other copyright and version information must be correct for the manufacturer.

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Driver files provided by the vendor must not use the same file names used by files included in Microsoft operating systems and provided as either retail or OEM products, unless specifically agreed upon with Microsoft.

- **Driver installation and removal use methods defined in the Windows NT DDK.** The device driver must be removable using Windows-based software by using either the Windows Control Panel option for removing devices or its own remove utility. For information, see the Windows NT 5.0 DDK.

  However, any software applications included with the device can be installed using an alternate Windows-based installation method as defined in the Microsoft Platform SDK. Also, any software components and registry entries installed during driver installation must be removed during driver removal.

- **Driver supports unattended installation.** It must be possible for a user to install a device's driver without being present. This unattended installation can be done using a mechanism such as a script or special software for supplying the required parameters.

- **Windows Help file is provided if special driver parameters are used.** This requirement ensures that the user can correctly change settings. The device's installation routine must install the Help file as part of the setup program. The user interface for the device's dialog boxes must display the correct Help file; the Help file must contain relevant information to assist the user. The guidelines for implementing Help are defined in the Windows NT DDK.

55. Keyboard and mouse connections meet requirements for bus and device classes

Required

These requirements, which depend on the type of connection designed into the system, ensure that all Plug and Play requirements are met and that Microsoft drivers support this device.

If a PS/2-style keyboard port is used, the following requirements must be met:

- Support PIC-based IRQ 1 on Intel Architecture systems, ensuring that software functions properly if it was written for legacy systems and expects to use this IRQ signal.
- Map the I/O address ports to 60h and 64h.
- Return expected scan codes, including send ID (0F2h) and response ACK (0FAh), plus 2-byte ID.

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If a PS/2-style mouse port is used, the following requirements must be met:

- Comply in full with requirements in the *IBM Personal System/2* specifications.
- Use a device with an 8042-compatible interface to the keyboard controller function to ensure compatibility with Windows NT. In most cases, the existing 8042 keyboard port is sufficient. The 8042 chip initiates a PIC-based IRQ 12 interrupt when the mouse is connected to the port.
- Support PIC-based IRQ 12 to ensure the proper functioning of software written for legacy systems that use this IRQ signal.
- Return expected codes, including send ID (0F2h) and response ACK (0FAh) + 1-byte ID.

If a USB connection is used, the following requirements must be met:

- Meet requirements in *Universal Serial Bus Specification, Version 1.0* or later.
- Meet requirements in *USB Human Interface Device Class Specifications, Version 1.0* or later.
- Implement minidriver support based on WDM HID class support in the operating system, as defined in the Windows NT 5.0 DDK.

If a USB keyboard is the sole keyboard implementation in an Intel Architecture system, it must provide boot support as specified in "Startup Support Requirements" of Chapter 2, "System Component Requirements," and as defined in *Universal Serial Bus PC Legacy Compatibility Specification, Version 0.9* or later. This support must provide the ability for the user to enter the system's BIOS setup program and provide enough functionality to get a USB-aware operating system installed and booted. On a DEC Alpha system, the keyboard must work as the input device using the ARC interfaces.

56. Serial port meets requirements for bus and device classes

Required

A serial port implementation that uses a non-legacy bus must meet the specific device class requirements for that bus. For example, a USB serial port implementation must comply with all related USB specifications, including:

- *Universal Serial Bus Specification, Version 1.0* or later.
- *Universal Serial Bus Class Definition for Communication Devices, Version 1.0* or later.

  The "Standard Serial Interface Circuit Emulation" appendix in the *USB Class Definition for Communication Devices* specifically addresses serial-port compatibility.

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If a legacy serial port is implemented in a server system, it must meet the following requirements:

- A 16550A buffered Universal Asynchronous Receiver/Transmitter (UART) or equivalent buffered legacy serial port is required to support high-speed communications while reducing the CPU requirements for servicing the device. The device must be able to support 115.2K baud.
- A legacy serial port must provide flexible resource configuration and complete dynamic disable capabilities as defined in the Plug and Play External COM Device Specification, *Version 1.0*. The following are the recommended resource settings for non-PCI devices:
  - Four I/O locations for each port (standard ISA I/O addresses are 3F8h, 2F8h, 3E8h, and 2E8h). Using the standard addresses ensures the proper functioning of software that directly addresses these locations.
  - Two IRQ signals (standard is PIC-based IRQ 3, IRQ 4). Support of the standard IRQ signals ensures the proper functioning of software written for systems that use standard IRQ signals.

  Two IRQs are required for each port. If two serial ports are implemented in the system, the following IRQ assignments are recommended:
  - For serial port A: selection between PIC-based IRQ 4 and IRQ 11.
  - For serial port B: selection between PIC-based IRQ 3 and IRQ 10.
- In the event of an irreconcilable conflict with other serial ports on the system, a legacy serial port must be capable of being disabled by Plug and Play software. This capability allows at least one of the two conflicting serial ports to operate correctly.
- The BIOS must configure at least one serial port to use either 2F8h or 3F8h. This requirement allows the port to be treated as a boot device by the BIOS so that components can use the port for diagnostic purposes in the event that system debugging is required by either the BIOS or the operating system.

57. Parallel port meets requirements for bus and device classes

Required for all server types, with ECP support required for SOHO servers

In addition to other capabilities listed here, the parallel port on a SOHO system must support the ECP protocol as defined by the IEEE 1284-1994 specification. This capability allows connections with higher-speed parallel peripherals.

A parallel port implementation that uses USB must comply with all related USB specifications, including the USB core specification and any specific device class specification.

If implemented in a server system, a legacy parallel port must provide flexible resource configuration following the *Plug and Play Parallel Port Device Specification, Version 1.0b.* Resource requirements must be met for each device of

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this type on the system. The requirements cannot be split between two ports on the system.

For non-PCI devices, the minimum resource requirements for each parallel port on the system are as follows:

- The parallel port must support ISA I/O addresses of 378h and 278h, plus 3BC or a vendor-assigned I/O address. Using these standard I/O addresses ensures proper functioning of software written for operating systems that directly address these locations.

  Recommended: Map the base I/O address to four additional locations.

- The parallel port must support PIC-based IRQ 5 and IRQ 7. Using these standard IRQs ensures proper functioning of software written for operating systems that use standard IRQ signals.

  Recommended: Support five additional IRQ signals.

- The parallel port must support two unique DMA channel selections if its design supports block data transfers to memory using DMA controllers. Notice also that the DMA function will not work on a parallel port without an IRQ because the end of a DMA transfer is signaled by an interrupt.

To ensure Plug and Play support for resolution of resource conflicts, a full list of options for all possible configuration combinations must be enumerated, including:

- Options for both extended capabilities port (ECP) mode, which requires an I/O address, an IRQ, and a DMA selection, and standard LPT mode, which requires only an I/O address.
- Options that specify only the I/O address, which allows Windows NT to assign the IRQ and DMA channel.

On Intel Architecture systems, Windows NT considers the parallel port base address stored in the first BIOS Data Area (BDA) locations to be LPT1. The address stored in the second location is LPT2, and so on. On DEC Alpha systems, the information is in the ARC tree. On all ACPI-based systems, the information is obtained through the ACPI tree.

A legacy parallel port implemented in a server system must also meet the following requirements:

- Enhanced parallel port (EPP) support does not use restricted I/O addresses. Some EPP implementations require eight contiguous I/O ports. If EPP support is implemented, the hardware cannot use the ISA I/O address 3BCh as a base I/O address because VGA devices require use of port 3C0h.
- Compatibility, nibble mode, and ECP protocols meet IEEE 1284-1994 specifications. Support for a parallel port must include the compatibility mode and nibble mode protocols required by the IEEE 1284-1994 specification for

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minimum compliance. This support allows other IEEE 1284-compliant devices to be connected without problems.

Recommended: Port supports the ECP protocol as defined by IEEE 1284, allowing connections with higher-speed parallel peripherals. However, if the port can support the compatibility and nibble mode protocols as described earlier, it complies with the Basic and Enterprise class guidelines that allow connection of other IEEE 1284-compliant devices.

- Port connectors meet the minimum requirements defined in the IEEE 1284-I specifications. IEEE 1284-I–compliant ports must use a standard DB25 connector found on existing system parallel port designs. This connector is called an IEEE 1284-A connector in the specification.

  IEEE 1284-II–compliant ports must use an IEEE 1284-C connector. This connector is used on both the port and the peripheral device.

- IEEE 1284 peripherals have Plug and Play device IDs. The device ID is described fully in the IEEE 1284 specification. All characters in the device identification string must consist only of ASCII values 20h–7Fh. The device identification string consists of a leading zero, a hexadecimal value that represents the length of the string, and then a set of fields, in ASCII, with a unique identification string.

  In addition to the requirements specified in the *Plug and Play Parallel Port Device Specification, Version 1.0b*, the device ID string must contain the following keys, at a minimum. The keys are case sensitive and can be abbreviated in INF files as indicated.

Required key	Abbreviated string
MANUFACTURER	MFG
MODEL	MDL
CLASS	CLS
DESCRIPTION	DES

  All MANUFACTURER and MODEL key values must remain unique for each manufacturer. All MANUFACTURER, MODEL, CLASS, and DESCRIPTION key values must remain static for a specific unit; ID values do not change for different hardware configurations. For example, a user adding a memory module to a printer should not change the MODEL key value reported as part of the device identifier. However, if the user adds memory by installing an upgrade kit that requires a different driver or requires the existing driver to behave differently, then changing the MODEL value is acceptable as part of the upgrade installation process.

  The CLASS key describes the type of parallel device. The CLASS key can contain the values PRINTER, MODEM, NET, HDC, PCMCIA, MEDIA, FDC, PORTS, SCANNER, or DIGCAM. HDC refers to hard disk controller. MEDIA refers to any multimedia device. FDC refers to floppy disk controller.

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The DESCRIPTION key is an ASCII string of up to 128 characters that contains a description of the device that the manufacturer wants to have presented if a device driver is not found for the peripheral.

For information about how the system determines the correct peripheral device driver, see the Windows NT DDK.

Recommended: The CID key can provide a value that exactly matches a peripheral name supported by a device driver shipped with Windows NT Server. The value must match a value listed in the device's INF file.

58. System includes emergency repair support

Required

Floppy disk support is recommended for emergency-repair disk purposes; if an OEM does not provide a floppy disk drive for this purpose, an alternate emergency repair method must be provided.

If a floppy disk drive is provided, the recommended support should be a solution based on an external bus, supporting migration away from legacy devices. If implemented as an IDE floppy drive, the drive must comply with ANSI NCITS T10 *Multi-Media Command Set-2* (MMC-2).

59. Primary graphics adapter meets minimum requirements

Required

At a minimum, the adapter must support 800 × 600 × 256 color, following the VESA specification for this mode.

The adapter must also work normally with the default VGA mode driver, which is required for installing the operating system, so the primary adapter must support 4-bit planar VGA mode.

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CHAPTER 4

Networking and Communications Requirements

This chapter defines basic feature requirements for network adapters and other communications hardware. See also the related requirements for remote new system setup and service boot support using Dynamic Host Configuration Protocol (DHCP) and Trivial File Transfer Protocol (TFTP) as defined in "Manageability Requirements" of Chapter 7, "Reliability, Availability, and Serviceability Requirements."

In this guide, all network communications devices are based on the same Network Driver Interface Specification (NDIS) 5.0 requirements, which includes requirements for power management and Plug and Play capabilities. NDIS 5.0 represents a number of extensions to the interface described in NDIS 3.0 and 4.0. The basic requirements, services, terminology, and architecture of these earlier versions also apply to NDIS 5.0. The new NDIS architecture is included in Windows NT 5.0 and is documented in the Windows NT 5.0 DDK. For additional background information about NDIS 5.0, see the web site at http://www.microsoft.com/hwdev/network/.

Note: References to adapters, network interfaces, and so on in this chapter should be taken to apply to add-on network adapter cards, network implementations on the system board, and external network interfaces equally and without preference for any of these types of implementation, unless otherwise noted.

Network Adapter Requirements

This section describes the requirements for network adapters. Many of these requirements also apply to other network communications devices such as ISDN, cable modem, and ADSL. The section for each device category lists the applicable requirements for that device.

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Note: It is recognized that OEMs supply server systems to corporations in situations where the customer will insert network adapters at the end-user site. Systems designed for specific corporate customers are exempt from including a network adapter. However, if a network adapter is included in the system, it must meet these requirements.

Also, references in this chapter to adapters, network interfaces and so on should be taken to apply equally to add-in network adapter cards, network implementations on the system motherboard, and external network interfaces, without preference for any of these types of implementation unless otherwise noted.

60. System includes non-ISA NDIS 5.0 network adapter

Required

An ISA-based network adapter solution is not allowed for a server system.

61. Network adapter uses NDIS 5.0 miniport driver

Required

The network adapter driver must be based on and comply with NDIS 5.0 in order to take advantage of new operating system capabilities. The driver must follow the NDIS miniport driver model defined in the Windows NT 5.0 DDK.

Important: The development of full MAC drivers is no longer supported. Support for full MAC drivers will be removed in the future versions of Windows.

If the network device is for connection-oriented media, such as Asynchronous Transfer Mode (ATM), ISDN, Frame Relay, or X.25, it must have a connection-oriented miniport driver that follows the connection-oriented model defined for NDIS 5.0 in the Windows NT 5.0 DDK. Also, for the connection-oriented media, there needs to be an NDIS 5.0 call manager driver as defined in the DDK.

In some cases, such as ATM, the call manager driver is included in the operating system and the vendor needs to provide only an NDIS 5.0 connection-oriented miniport driver. For other connection-oriented media, such as ISDN or X.25, the call manager is not included in the operating system and must be provided with the hardware. The call manager support can be integrated in the connection-oriented miniport driver or implemented as a separate NDIS 5.0 call manager driver. The documentation of both options, integrated or separated call manager, is included in the Windows NT 5.0 DDK.

An intermediate NDIS 5.0 miniport driver is required for network adapters that connect to the system using IEEE 1394 or USB buses. This driver exposes its media type to NDIS at its upper edge and interfaces with the appropriate bus driver, IEEE 1394 or USB, at its lower edge.

The NDIS 5.0 miniport driver must also meet these requirements:

- **Driver works correctly with Microsoft network clients and protocols.** This includes the 32-bit Microsoft client and NetWare-compatible clients provided with Windows, whether connected to a Windows NT-based server, a

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Novell NetWare 3.x or 4.x server, or a Windows-based peer server. In all cases, this includes connections using Microsoft Transmission Control Protocol/ Internet Protocol (TCP/IP), IPX/SPX-compatible protocol, and NetBEUI in Local Area Networks. In Wide Area Networks, connections must work correctly using TCP/IP.

- **Driver makes only NDIS library calls or WDM system calls.** NDIS conformance must be validated over single and multiple network connections. For Windows NT, this must be validated on a multiprocessor system as part of the testing process.
- **Driver uses new INF format.** All network components must use the new style of INF format, which is based on the Windows 95 INF format. For information, see the Windows NT 5.0 DDK.

  For Windows NT 5.0, there will be no legacy INF support and no satisfactory upgrade option for OEM components created for Windows NT 4.0.
- **Driver is deserialized.** NDIS 5.0 introduces support for deserialized miniports. This enables performance improvements and scalability on Windows NT multiprocessor systems.

62. NDIS 5.0 miniport driver supports high-performance send and receive calls

Required

NDIS drivers for server-side network adapters must support the new higher performance send (NdisSendPackets) and receive (NdisMIndicateReceivePacket) calls documented in the Windows NT 5.0 DDK.

63. Network adapter offloads TCP/IP checksum, IP Security encryption, and TCP message segmentation

Recommended

Server-side network adapters should support task-offload mechanisms to offload TCP/IP checksum calculation, IP Security encryption, and TCP message segmentation to intelligent hardware. This provides better utilization of computing resources on the server system. Mechanisms for off-loading these tasks are documented in the Windows NT 5.0 DDK NDIS documentation.

64. Full-duplex adapter automatically detects and switches to full-duplex mode

Required

The network adapter must negotiate full duplex operation by default when both the network adapter and switch port in a link pair support full duplex and the networking technology provides a standard way for each to detect and/or negotiate the duplex mode. Half duplex may be used if that is the only mode supported by one or both link partners or if it can be manually configured when warranted by special conditions. The goal is to configure this setting automatically without end-user intervention.

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65. Adapter automatically senses presence of functional network connection

Required

Where the network media allows it, the network adapter must be capable of dynamically determining whether it is connected to a functional link partner such as a hub, switch, or router. The device must indicate the link state in the following cases:

- At boot time
- After returning to D0 power state
- When the link state changes while in the D0 power state (no time limit is specified for the required detection or status indication)

If the adapter is on an expansion card not used as a boot device, then the device drivers can determine the presence of the functional link. If the device is not connected to a functional link partner, the miniport driver must provide appropriate NDIS status indication, using support for cable sense in NDIS 5.0.

For information about NDIS status codes and indication mechanisms, see the Windows NT 5.0 DDK.

66. Adapter automatically senses transceiver type

Required

Network adapters that support multiple transceivers must be capable of automatically detecting which transceiver type is connected to the network unless this is not possible with the network media at hand. The network adapter then must automatically drive the correct connection. In all cases, the user must not be required to set jumpers or manually enter information to inform the operating system of the transceiver type.

67. Adapter can transmit packets from buffers aligned on any boundary

Required

Buffer alignment refers to whether a buffer begins on an odd-byte, word, double word or other boundary. Adapters must be able to transmit packets any of whose fragments are on an odd-byte boundary.

For performance reasons, packets should be received into contiguous buffers on a double word boundary.

68. Adapter communicates with driver across any bridge

Required

If the adapter uses a bridge, all communications must be free of errors across any bridge, such as a PCI bridge adapter.

69. Adapter supports filtering for at least 32 multicast addresses

Required

This recommendation applies to those networking technologies that support multicast, such as Ethernet, but it does not apply to those which do not, such as

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Token Ring. Token Ring for example, distributes IP multicast traffic using the functional address, as specified in RFC 1469.

This capability is needed to support new "push" technology applications such as Microsoft NetShow™, Active Desktop, and Internet Explorer 4.0. The minimum required capability is for filtering 32 multicast addresses (also known as channels).

70. Adapter supports configuration capabilities and registry settings for performance tuning

Required

Some network adapters and drivers might support additional configuration capabilities for performance tuning when used in special environments or applications. Any tuning parameters that are set by the user, an application, or the operating system must be controlled through registry variables.

An example of such performance optimizations might be adjustment of interrupt moderation or the number of receive buffers for systems used as dedicated routers.

In addition to Dynamic Interrupt Moderation, there are other techniques that may be implemented on network adapters to maximize system performance for special environments or applications.

User-tunable parameters must be set through registry variables as parameters for network adapters and must not be set in .INI files, configuration files, or in other locations. These parameters can be accessed using the Advanced Page in the Device Manager. The variables should be set through standard user interfaces provided in Windows.

71. Server network adapter supports remote system setup capabilities

Recommended

It is strongly recommended that server network adapters support remote new system setup capabilities as defined in *Network PC System Design Guide, Version 1.0b* or later.

72. Network connections used for remote boot meet Net PC v.1.0b requirements for remote system setup

Required

On server systems that support remote new system setup, network connections used for remote boot must comply with remote new system setup capabilities as described in *Network PC System Design Guide, Version 1.0b* or later. It must be possible to enable and disable the remote boot (remote new system setup) capabilities through administrative control in order to maintain server security.

Note: Multiport network adapters can supply remote system setup capabilities on none, any, or all ports.

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73. PCI network adapter properly supports higher-level PCI commands

Required

PCI commands are defined in the PCI 2.1 specification. This requirement ensures efficient data transfer.

74. Adapter and driver support promiscuous mode

Required

This ensures that the adapter can be used with Microsoft Network Monitor Agent. This requirement applies only to LAN (non-switched) media.

Notice that, by default, promiscuous mode is not turned on. Enabling promiscuous mode should be possible only by using the Microsoft Network Monitor Agent or another similar administrative application.

75. Adapter and driver support multicast promiscuous mode

Required

By supporting this feature, the adapter and the driver enable performance improvements for special-purpose servers and applications, such as multicast routers. This requirement applies to those networking technologies that support multicast, such as Ethernet, and not to those which do not, such as Token Ring.

Notice that, by default, multicast promiscuous mode is not turned on.

76. Network adapter and driver support priority for IEEE 802-style networks

Recommended

Windows Quality of Service (QoS) components will provide link layer priority information to NDIS 5.0 miniport drivers in each transmitted packet's NDIS_PER_PACKET_INFO structure. Priority values are derived by mapping IETF Integrated Services (intserv) service types to 802.1p priority values (referred to as the "user priority" object in http://search.ietf.org/internet-drafts/draft-ietf-issll-is802-svc-mapping-01.txt, which is likely to be superceded by a later draft or final specification). The intserv service type used for the mapping is determined by QoS-aware applications or on behalf of the application, by QoS-aware operating system components.

802.1p/q-capable Ethernet drivers are expected to use the priority level indicated in the NDIS_PER_PACKET_INFO structure to generate the corresponding field in the 802.1p/q MAC headers of transmitted packets. Similarly, these drivers are expected to extract the appropriate information from the MAC headers of received packets and to copy the priority to the NDIS_PER_PACKET_INFO structure before indicating the packet to higher protocol layers.

Note that any link layer driver may interpret the priority information in the NDIS_PER_PACKET_INFO structure and use it as appropriate for the particular media.

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For more information, see the Windows NT 5.0 DDK. See also the article "QoS: Assigning Priority in IEEE 802-style Networks," available on the web at http://www.microsoft.com/devdes/qos802.htm.

77. Device Bay network adapter meets requirements

Required

Any networking communications device designed as a Device Bay peripheral must interface with either USB, IEEE 1394, or both, and must support relevant USB device class specifications. All Device Bay peripherals must meet the requirements defined in *Device Bay Interface Specification, Version 1.0* or later. See also requirement #16, "Device Bay controller and devices meet Device Bay 1.0 and other requirements."

78. PCI network adapters are bus masters

Required

To improve the system performance by decreasing the load on the system processor, the PCI network adapters must be bus masters.

79. USB or IEEE 1394 network device complies with related device class specifications

Recommended

USB network communications device vendors should implement forthcoming networking extensions to the USB Class Definitions for Communications Devices.

Vendors are also encouraged to participate in the definition and implementation of both USB and IEEE 1394 working group efforts.

80. Network device and driver meet Plug and Play and power management requirements.

Required

The additional Plug and Play and power management requirements for network communications devices include the following:

- **Plug and Play capabilities support multiple adapters.** For network communications devices, the Plug and Play IDs and resource support must be sufficient to automatically support the addition of multiple network communications devices to the system. This is true for the same and different types of network communications devices.
- **All resource settings are reported in the user interface.** All resource settings must be viewable in the Device Manager and in adapter properties dialog boxes. All resource settings that can be changed by the user must be changed using the standard Windows user interface and not by way of INI files or other setting files.

  This implies that all device resources must be set and read through the device's standard bus interfaces. For PCI devices, this interface is the PCI

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configuration space. Further, device parameter settings must be stored in the registry.

81. Network communications device supports wake-up events

Recommended

This requirement applies specifically to the following network communications devices and their associated NDIS 5.0 miniport drivers:

- Ethernet and Token Ring network adapters
- Integrated DOCSIS cable modems
- Other or future devices that transfer 802.3/DIX Ethernet framed packets

The *Network Device Class Power Management Reference Specification, Version 1.0* or later, does not yet define wake-up mechanisms for ISDN adapters or any network communications adapter that uses ATM signaling.

The system must be capable of being awakened from a lower power state based on network events specified by the local networking software. This capability yields the result that any standard Windows network access—such as connections to shared drives and WinSock connections, plus service and management applications—can awaken a system from lower power states transparently.

As defined in *Network Device Class Power Management Reference Specification,* a network adapter and its driver must support wake-up on receipt of a network wake-up frame. Support for wake-up on detection of a change in the network link state or on receipt of a Magic Packet event is optional. Implementation details are described in the "Network Wake-up Frames" and "Network Wake-up Frame Details" sections of *Network Device Class Power Management Reference Specification, Version 1.0a* and in the Windows NT 5.0 DDK. See also the implementation notes at http://www.microsoft.com/hwdev/devdes/netpm.htm.

The packet patterns that define the wake-up frames are provided to the NDIS 5.0 miniport driver by the operating system. To enable Wake-On-LAN capability for basic networking scenarios, the network interface card must be capable of storing information describing a minimum of four wake-up packet patterns, and it must be able to recognize wake-up packets based on pattern matches anywhere in the first 128 bytes of the packet. The network adapters should be capable of storing information describing at least eight wake-up packet patterns to enable more advanced applications such as Wake-On-LAN capability on multi-homed systems or on receipt of multicast packets, in addition to the above basic scenarios.

PCI-based network adapters must support the generation of a power management event (PME# assertion) from the D3 cold device state if the physical layer technology is generally capable of operating under the voltage and current constraints of the D3 cold device state. For example, 100baseTX adapters can meet this requirement based on the state of the art in mid-1988. 1000baseSX or 1000base LX (gigabit Ethernet using optical fiber media) cannot meet this requirement because of the power required to operate the optical physical layer.

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Modem Requirements

This section presents general requirements for modems.

There are two types of modems to consider.

- Traditional modems, such as the type used in common PCs that are connected to the server system by a serial port, or a driver that emulates one.
- Network modems, designed for large servers, that are connected to the server system by networking drivers, for example, NDIS 5.0 miniports.

Serial modems. The fundamental design principle for compatibility with Windows NT is for a serial modem to be supported by the Universal Modem Driver (Unimodem), which uses INF files to characterize device operation. Unimodem INF design is described in the Modem Developer's Kit, http://www.microsoft.com/hwdev/modem/.

Networking modems. The fundamental design principle for compatibility with Windows NT is for a networking modem to be supported by NDIS 5.0, as defined in the Windows NT 5.0 DDK.

Note: It is recognized that OEMs supply systems to corporations in situations where the customer will insert modem devices at the end-user site or where the customer has particular feature demands. Server systems designed for specific corporate customers are exempt from these requirements.

Server Types and Modem Usage

This guide addresses Basic servers, SOHO servers, and Enterprise servers.

SOHO servers typically have a small number of serial modems, used for Remote Access (in or out), shared ISP access, FAX (in or out) and interactive voice response (IVR). The modems used are traditional serial modems, similar to those used for Workstation PCs, as defined in *PC 98 System Design Guide* or later. These modems are typically connected by individual PSTN phone lines or by ISDN BRI lines.

In an enterprise, the modem servers may support hundreds of modems, used primarily for inbound remote data access such as for an ISP or corporate network. The modems are typically connected to public networks on high speed digital lines (T1, ISDN, or PRI). Different servers may be used for dedicated incoming Fax reception or IVR. Note that Windows NT 5.0 Unimodem and TAPI can be used to support hundreds of modems for each server.

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Design Issues for Server Modems

For modems designed for Basic servers, the most important additional design issues are:

- Support for V.90, as host side modems where possible, which requires an ISDN or other digital network connection.
- Support synchronous PPP, using V.8bis and V.80.
- Do not migrate the modem signaling function, for example, V.90 or V.34, into the system.

For SOHO Server modems, the most important design issues are:

- SOHO Server modems must support adaptive answering features: V.8, V.8bis, V.251.
- Full duplex voice strongly recommended, using V.253, to support small scale Interactive Voice Response.

For Enterprise Server modems, the most important design issues are:

- The NDIS 5.0 miniport interface is preferred.
- Fax is optional, not mandatory, because the most common solutions use separate hardware and drivers, on separate public network connections.

82. System includes modem communications device

Recommended

The following device options, as defined later in this chapter, can meet this requirement:

- Serial modem with V.34 and V.90 56K ITU capabilities, supporting server fax capabilities (two or more ports recommended)
- ISDN adapter
- ATM adapter
- ADSL adapter

83. Modem supports ITU-T V.250, Hayes-compatible command set

Required

ITU V.250 (formerly V.25 ter) is a superset of TIA-602. TIA-602 codifies the most common data modem commands and responses.

V.250 also includes two additional components:

- A standard format for extending the AT command set, with standard means for the system to test the range of supported values for each command. This format enables adaptive modem installation.

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- Standard extensions for modem ID, port control, modulation control and reporting, error control, and data compression control and reporting. Use of these extensions can reduce or eliminate the need for data modem INF files.

The essential V.250 commands are the following:

- All basic modem commands from TIA-602
- Identification: +GMI, +GMM, +GMR
- Port control: +IPR, +ICF, +IFC, +Ilrr
- Modulation: +MS, +MR, +MA
- Error control: +ES, +ER, +EB, +ESR, +ETBM
- Data compression: +DS, +DR

The particular utility of the standard format is that it allows a future modem installer to adaptively install and use a modem with minimal need for INF minidrivers.

84. Data modem supports PCM (V.90) with V.42 and V.42bis protocol

Required

This is the minimum modem capability specified in this guide.

85. Data modem supports digital connection to support host-side V.90 operation

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Required*	*Required*	*Required*
SOHO:	*Recommended*	*Required*	*Recommended*

V.90 depends on a digital connection for the host-side modem to the public telephone network, typically using T1 or ISDN. Server modems should be designed for digital connection, to support host side V.90, where digital connections are available.

86. Fax modem supports 14.4 Kbps (V.17) with Class 1 (TIA-578-A) command set

Required

The following are recommended:

- Class 1.0 (ITU T.31) with +FAR support, which allows the hardware to perform adaptive carrier detection
- Class 2.0 (ITU T.32 or TIA-592) for server modems, which offloads the T.30 session protocol to the modem

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87. Fax modem supports adaptive DATA/FAX call classification based on T.32 +FAA

Required

The adaptive DATA/FAX call classification must be based on the Class 2.0 +FAA command or equivalent proprietary +FAE command. This allows a server to handle remote access calls and inbound FAX calls on the same lines.

Windows NT 5.0 and future versions of Microsoft BackOffice® products will support Class 1.0 and Class 2.0 fax modems, and use adaptive call-classification support. To benefit from this support, modem vendors should extend their modem INFs to support the new registry keys needed to support these features, as defined in the MDK.

88. Data modem supports V.80 for synchronous access

Required

This standard provides a control plane for the modem and synchronous access to the data path—the foundation for third-party voice/data/video software, for example, H.324 and V.70. Modems that support V.80 must also include V.8bis signaling and V.251 as described in requirement #85, "Modem supports adaptive connection, V.25, V.8, and V.8bis call control signaling with V.251 modem commands."

89. Modem supports adaptive connection, V.25, V.8, and V.8bis call control signaling with V.251 modem commands

Required

V.25 defines basic call-type selection, with an answer tone, a fax-calling tone, and a data-calling tone. V.8 defines advanced call-type selection, with complex information exchanged between terminals; V.8 is used in V.34, V.90, and some digital simultaneous voice/data (DSVD) implementations. V.8bis is required for standard multimedia modes, such as V.61 ASVD, V.70 DSVD, and H.324 video telephony, and to negotiate point-to-point synchronous PPP, supporting H.323.

V.251 enables the computer to participate in call control, allowing flexibility and a visual user interface, as well as saving modem complexity. V.251 requires DCE-controlled operation; in addition, DTE-controlled operation is recommended.

90. Modem supports blacklisted and delayed number clearing

Required where applicable

During certain international Post, Telephone, and Telegraph (PTT) certification processes, modems must support the blacklisted and delayed numbers feature. That means that when the modem fails to connect to a specific number for a certain number of times, the dialed number is stored in an internal list. Any subsequent automated dialing operation to this number is then either delayed for a time (delayed) or forbidden until some form of manual intervention occurs (blacklisted). The international certification processes specify that manual intervention using an external device is required in order to clear these numbers.

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The modem should clear its blacklisted and delayed number tables if the associated handset goes off hook.

91. Modem supports TDD, meeting V.18-1996 with V.250 AT commands

Recommended

People with deafness or reduced hearing can use Telephone Device for the Deaf (TDD), also known as Text Telephones, to communicate over phone lines. The U.S. Americans with Disabilities Act (ADA) requires all businesses of a certain size or larger to have Text Telephone services available and to be able to receive calls from people using Text Telephones.

In North America and Europe, the following types of Text Telephones are used:

- Baudot: 45 or 50 bps Frequency-Shift-Keyed (FSK) and 5-bit Baudot coding
- ASCII: 300 bps Bell 103 and 7-bit ASCII coding
- European Deaf Telephone (EDT): 110 bps half-duplex V.21 and 7-bit coding
- Minitel: V.23 modems and 7-bit coding
- Modems and 7-bit coding
- DTMF: 2-digit or 3-digit character coding

The International Telecommunications Union (ITU) recommendation V.18 codifies how all these devices work and how to adaptively connect to all of them. ITU recommendation V.25ter contains AT commands for control of V.18 features in a modem.

Text Telephone capability should be included for the type of modem commonly used in the country of sale and use, for example, Baudot in the United States, Minitel in France, and so on.

92. Modem controller meets minimum requirements

Required

The following are minimum requirements for the modem controller, in addition to supporting V.250:

- Unimodem Diagnostics command, AT#UD
- Software-upgradable modem controller (upgradable ROM or Windows modem)
- AT command buffer of at least 60 characters
- Semicolon (;) character dial string modifier, unless prohibited by national regulations

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93. Voice modem support is provided

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Optional*	*Optional*	*Optional*
Enterprise:	*Optional*	*Optional*	*Optional*
SOHO:	*Recommended*	*Recommended*	*Recommended*

Voice capability is recommended for SOHO server modems to support Interactive Voice Response and 3-way DATA/FAX/Voice call classification on the same phone lines. This support, if implemented, must meet the requirements documented in requirement #94, "Voice modem supports ITU V.253 (AT+V)."

94. Voice modem supports ITU V.253 (AT+V)

Required

TIA IS-101-1994, the Interim Standard for Voice DCE, has been superseded by TIA-695 and ITU V.253-1998.

Voice capability is not mandatory, but if support for voice modem is implemented in a server system, it must meet the following requirements:

- V.253 compliance
- Voice recording and playback (+VTX, +VRX)
- DTMF generation and detection during voice I/O
- Voice I/O support of 8-bit, 8-kHz PCM formats: unsigned linear, G.711 (A-law and u-law)
- Programmable gain control for all audio channels
- Speakerphone with automatic training (no user intervention)
- Voice I/O to the handset (for voice-only devices)
- Duplex voice, to support IP telephony and IVR
- Caller ID Detection and Reporting (+VCID)

ATM Requirements

This section summarizes requirements for ATM hardware.

The NDIS 5.0 extensions provide kernel-mode NDIS 5.0 client drivers with direct access to connection-oriented media such as ATM. The new architecture for Windows NT extends native ATM support to Windows Sockets 2.0 (WinSock), Telephony API (TAPI), and applications based on Microsoft DirectShow™ by providing system-level components that map the applicable WinSock, TAPI, and DirectShow APIs to NDIS 5.0, extending direct ATM access to user-mode applications.

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ATM is not required for any of the server classes. If an ATM adapter is designed for operation under Windows NT in the server system, it must meet the requirements defined in this section. For more details about the following requirements, see "ATM Layer Specification" in *ATM User-Network Interface Specification, Version 3.1.* This specification also includes references to other relevant specifications.

95. ATM adapter meets network adapter requirements

Required

The following network device requirements must be met:

- #61, Adapter uses NDIS 5.0 [connection-oriented] miniport driver
- #65, Adapter automatically senses presence of functional network connection
- #67, Adapter can transmit packets from buffers aligned on any boundary
- #68, Adapter communicates with driver across any bridge
- #77, Device Bay network adapter meets requirements
- #78, PCI network adapters are bus masters
- #79, USB or IEEE 1394 network device complies with related device class specifications

96. ATM adapter supports a minimum number of simultaneous connections

Required

The VPI (Virtual Path Identifier) and VCI (Virtual Channel Identifier) ranges supported by the adapter affect the maximum number of simultaneous connections supported on a system.

This affects the applicability of the adapter to ATM applications such as LAN Emulation, where at least one dedicated virtual channel is created between each pair of communicating ATM hosts.

System type	Simultaneous connections
Client (ATM adapter)	64 or more
Client (Integrated ATM/ADSL-adapter)	16 or more
Server	2048 or more

A sample driver is provided in the Windows NT DDK to guide developers in properly supporting resources to meet this requirement.

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97. ATM adapter supports all service types defined by the ATM Forum

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Required*	*Recommended*

The ATM adapter should support the constant bit rate (CBR), variable bit rate (VBR), available bit rate (ABR), and unspecified bit rate (UBR) service types as defined by the ATM Forum.

98. ATM adapter supports UBR service type

Required

UBR is used by default for standard ATM services such as LAN Emulation and IP over ATM. In addition, PPP is a widely used model for residential network access and UBR is used by default for PPP over ATM virtual circuits. Therefore, it is required that ATM adapters support the UBR service type.

99. ATM adapter supports a minimum number of simultaneously active VBR or CBR connections

Required

Support for at least two simultaneously active VBR or CBR connections is required for basic ATM signaling and management.

Support for additional VBR/CBR connections is needed for ATM adapters that support multimedia or other traffic that demands Quality of Service (QoS). These are listed in the following table.

System type	Simultaneous active VBR/CBR connections
Client	6
Server	500

100. ATM adapter supports traffic shaping

Required

The ATM adapter must support and enforce all the traffic-shaping rules specified for each service type it supports, including CBR, VBR, ABR, and UBR.

Note: This includes enforcement of peak cell rate on UBR virtual circuits.

101. ATM adapter enforces PCR on UBR virtual circuits

Required

ATM adapters will be used to connect router, remote access, and content servers to the public ATM network. High-speed residential broadband access networks such as ADSL and cable modem will use an ATM virtual circuit from home or small office computers to connect directly to these servers. When the Windows Dial-Up Networking UI is used to connect from a home or small business computer to a remote router or server, a PPP link is established over an ATM virtual circuit.

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The service type used on this PPP over ATM virtual circuit is unspecified bit rate (UBR). When creating the UBR virtual circuit, Windows will request upstream and downstream line rates, or Peak Cell Rates (PCR), equal to the upstream and downstream line rates provisioned for the user. Windows uses the ATM Interim Local Management Interface (ILMI) protocol to obtain information, such as getting the user's provisioned line rates from the public network.

To avoid packet loss and ensure efficient network utilization, it is critical that all ATM, integrated ATM/ADSL adapters, or ATM/cable modem adapters enforce requested PCR on UBR virtual circuits.

Because any ATM adapter might be installed in a server to which clients connect through the public network, this requirement applies to all ATM adapters.

102. ATM adapter and driver support dynamic link speed configuration

Required

When connected to a residential broadband network, ATM adapters must restrict the aggregate transmission rate across all active virtual circuits so that it does not exceed the provisioned upstream bandwidth of the residential broadband network.

All integrated ATM/ADSL and ATM/cable modem adapters must support aggregate shaping of upstream bandwidth according to the provisioned upstream bandwidth or the trained bandwidth, whichever is lower. Some implementations can support rate adaptation, and lower than provisioned rates may be negotiated due to poor line conditions. All 25-Mbps ATM adapters must support this as well, because any 25-Mbps ATM adapter could be used to connect by way of an external ADSL modem to an ADSL network. This support is optional for ATM adapters with line rates higher than 25 Mbps.

The Windows ATM Call Manager uses ILMI to query the public network to discover the provisioned maximum line rates for incoming and outgoing traffic. The Call Manager then uses the *OID_GEN_CO_LINK_SPEED* NDIS request (in SET mode) to set the line rate for both incoming and outgoing traffic. The adapter must shape the aggregate of ATM traffic within these incoming and outgoing rates.

103. ATM adapter supports OAM

Required

Operation and maintenance (OAM) is needed for diagnostics. This capability is required for a server system. At minimum, the ATM adapter must respond to received F4 and F5 loopback OAM cells. Support for other layers, F1–F3 is optional.

104. ATM adapter supports buffer chaining (Tx + Rx)

Required

This feature is needed for large packets. This capability is required for server systems, but is recommended for client systems.

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ADSL Requirements

This section summarizes requirements for ADSL hardware.

Support is provided in the Windows NT Server operating system for ADSL adapters and external ADSL modems, such as those using USB, which provide a faster method for moving data over regular phone lines. ADSL adapters are not required for any server type, but if an adapter is included in a server, it must meet the requirements in this section. ADSL is not required in a server system, but if present, it must comply with these requirements.

Please review the white paper, *An Interoperable End-to-End Broadband Service Architecture over ADSL Systems Version 3.0*, which discusses end-to-end service interoperability over ADSL. This paper, which is available from the web site at http://www.microsoft.com/hwdev/publicnet/, was jointly developed by over 30 leading ADSL vendors. The core idea of this white paper (PPP over ATM over ADSL) has been adopted by the ADSL Forum.

105. ADSL device is implemented as an integrated ADSL modem

Recommended

System designers should integrate the ADSL modem and higher layer transmission and media access functions on a single network device. A typical implementation integrates an ADSL modem and ATM interface on a single PCI network adapter. Another example is a device that connects to the server using the USB or IEEE 1394 bus.

If external ADSL modems are provided (other than IEEE 1394 or USB), it should have an ATM interface for the ADSL modem to server connection. In addition, an Ethernet interface can also be included.

106. Integrated ADSL modem meets network adapter requirements

Required

For the integrated ADSL modem, the following network adapter requirements must be met:

- #65, Adapter automatically senses presence of functional network connection
- #67, Adapter can transmit packets from buffers aligned on any boundary
- #68, Adapter communicates with driver across any bridge
- #77, Device Bay network adapter meets requirements
- #78, PCI network adapters are bus masters
- #79, USB or IEEE 1394 network device complies with related device class specifications

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For the integrated ADSL modem exposing an ATM interface, the following requirements must be met as defined in "Network Adapter Requirements" earlier in this chapter:

- #61, Adapter uses NDIS 5.0 [connection-oriented] miniport driver

For the integrated ADSL modem exposing an Ethernet interface, the following requirements must be met as defined in "Network Adapter Requirements" earlier in this chapter:

- #61, Adapter uses NDIS 5.0 miniport driver
- #69, Adapter supports filtering for at least 32 multicast addresses
- #74, Adapter and driver support promiscuous mode

107. ATM/ADSL solution is implemented for integrated ADSL modems

Recommended

An integrated ADSL modem should expose ATM to the operating system. For ATM-specific requirements when an ATM/ADSL solution is implemented, see the requirements in "ATM Adapter Requirements" earlier in this chapter. This should comply with the PPP over ATM architecture discussed earlier.

Note: ATM/ADSL is a requirement for UADSL implementations. Currently there are both ATM/ADSL and Ethernet/ADSL based implementations to provide full rate ADSL services in the market. For compatibility with the Universal ADSL based services that will be rolled out within the next couple of years, PPP/ATM/ADSL is the required implementation.

108. ADSL modem supports DMT line encoding

Recommended

The ADSL modem must support DMT line encoding, which is recognized as the industry standard for ADSL by ANSI as the T1.413 Issue 2 specification and also by the Universal ADSL Working Group. For information, see the web site at http://www.uawg.org.

Note: DMT is a requirement for UADSL implementations. The UAWG has adopted DMT specified by T1.413, with modifications being made to work in a splitterless environment.

109. ADSL modem supports rate adaptation

Recommended

On a rate adaptive digital subscriber line (RA-ADSL), the downstream and upstream data rates are independently set either by an automatic adaptive algorithm or by manual selection.

RA-ADSL provides the capability to optimize the transmission speed and performance over a wide range of telephone-line loop distances. Adaptive channel equalization ensures more robust performance in the presence of channel impairments and narrow-band interference.

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This also helps telephone companies to provision RA-ADSL access on their existing networks. RA-ADSL products can be provisioned on many telephone lines without costly and time-consuming network upgrades.

Cable Modem Requirements

Cable modems are not required on servers. If they are implemented, they must meet the requirements in this section.

Cable modem provides two-way services: Data flows downstream from the cable operator's head end and upstream from the customer's PC. At the head end, the cable data system is terminated by the cable modem termination system (CMTS), which terminates the upstream and downstream radio frequency (RF), MAC layer, and possibly Layer 3 protocols from the cable side. CMTS provides the internetwork connection between the cable system and the rest of the network at the head end. CMTS can be implemented on a proprietary hardware platform or a PC platform running Windows NT to provide different networking functions such as routing, Quality of Service (QoS) support (such as RSVP), and so on.

Some implementations transmit upstream using narrow-band networks such as ISDN or analog modem, but as cable companies upgrade their networks, an increasing number of RF return modems, for example, two-way modems, are being deployed. Two-way modems are preferred, because they are always connected, perform better, and do not tie up phone lines or require modem banks.

The three current cable modem specifications are:

- Data-Over-Cable Service Interface Specification (DOCSIS), developed by the Multimedia Cable Network System (MCNS) consortium.
- IEEE 802.14, developed by IEEE.
- Digital Video Broadcasting/Digital Audio-Visual Council (DVB/DAVIC), developed by DAVIC and DVB and adopted by European Telecommunication Standards Institute (ETSI) and International Telecommunication Union (ITU).

Industry support for DOCSIS is growing rapidly in North America. In present form, its upper layers fully describe IP traffic encapsulated by 802.3/DIX Ethernet framing. ATM is left for future study.

External Ethernet DOCSIS cable modems provide IEEE 802.1d bridging for one or more Customer Premises Equipment (CPE); a PC attaches to them indirectly through its 10BASE-T network adapter. Integrated cable modems attach directly to the PC over buses such as USB, PCI, and IEEE 1394, and require a vendor-supplied NDIS 5.0 miniport driver. This driver exposes an 802.3/DIX Ethernet adapter interface to the operating system and it interfaces to the cable modem hardware using the appropriate bus (PCI) or bus interface driver (USB or IEEE 1394) at its bottom edge.

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In contrast to DOCSIS, both the 802.14 and the DVB/DAVIC efforts are focused on using ATM, typically implementing an ATM adapter interface and using an NDIS 5.0 ATM miniport driver.

110. Device is implemented as an integrated cable modem

Recommended

An integrated cable modem should be used for servers. This recommendation means integrating everything from the cable modem's physical interface layer, such as an RF coax connector, up through a standard PC 802.3/DIX Ethernet or ATM adapter MAC interface onto a single device. In other words, the software perceives the integrated cable modem as a standard Ethernet or ATM network adapter.

An example of this is a USB-attached DOCSIS implementation that integrates cable modem Physical Media Dependent (PMD), downstream convergence, cable MAC, link security, 802.3/DIX MAC "adapter" filtering, and USB device interface functions in the same box. Similar devices can be implemented that are attached using PCI or IEEE 1394 buses.

111. Integrated cable modem meets network adapter requirements

Required

For the integrated cable modem, the following network adapter requirements must be met:

- #65, Adapter automatically senses presence of functional network connection
- #67, Adapter can transmit packets from buffers aligned on any boundary
- #68, Adapter communicates with driver across any bridge
- #69, Adapter supports filtering for at least 32 multicast addresses
- #77, Device Bay network adapter meets requirements
- #78, PCI network adapters are bus masters
- #79, USB or IEEE 1394 network device complies with related device class specifications

For the integrated cable modem exposing an ATM interface, the following requirements must be met as defined in "Network Adapter Requirements" earlier in this chapter:

- #61, Adapter uses NDIS 5.0 [connection-oriented] miniport driver

For the integrated cable modem exposing an Ethernet interface, the following requirements must be met as defined in "Network Adapter Requirements" earlier in this chapter:

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- #61, Adapter uses NDIS 5.0 miniport driver
- #69, Adapter supports filtering for at least 32 multicast addresses
- #74, Adapter and driver support promiscuous mode

112. Integrated cable modem exposes an ATM or Ethernet interface
Required
Refer to ATM Adapter requirements for ATM-specific requirements if an ATM/cable modem solution is implemented.

ISDN Requirements

This section summarizes requirements for Integrated Service Digital Network (ISDN) hardware.

Under these guidelines, ISDN is recommended, but not required, for high-speed connections. If implemented in a server system, ISDN must meet the requirements defined in this section.

There are two classes of ISDN adapters:

- Serial port devices, supported by Unimodem with INFs
- Parallel bus devices, supported by NDIS WAN drivers

In this section, “internal ISDN device” refers to the ISDN terminal adapter, which exposes raw access to its B channels using NDIS miniports. WDM supported bus classes, such as USB or IEEE 1394, also can be used to attach external devices using NDIS miniports.

“ISDN modem” refers to an internal or external ISDN device that exposes itself as a modem controlled by the AT command set. To the operating system, these devices look like and can be used as modems, provided that the hardware manufacturer has done work to ensure these devices have the following capabilities:

- Interpretation of the standard modem AT command set, either in the ISDN device itself or in a serial port driver. For more information, see the TIA-602 specification, which is a subset of ITU V.250.
- A modem INF file for installing the device and for telling Unimodem which commands to use to control the ISDN device.

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Serial ISDN Modems

The requirements in this section apply for a serial ISDN modem designed for or included with a server system that complies with *Hardware Design Guide Version 2.0 for Windows NT Server*.

ISDN modems share the following features:

- ISDN Basic Rate interface (2B+D)
- Serial AT command language, with proprietary ISDN extensions

ISDN modems also share the following differences from wireline PSTN modems:

- User (or device) must configure for switch type and service profile ID (SPID)
- Data only, in increments of one or two 64,000 bps B channels
- Fax not available
- V.42 and V.42bis usually not available

113. ISDN modem supports required command set

Required

An ISDN modem must support basic AT commands: TIA-602, which is a subset of ITU V.250. The ISDN modem shall support commands to select the end-to-end protocol used over the ISDN; synchronous PPP, V.110, V.120, and so on. Also, commands must be included to set the switch type, subscriber numbers or directory numbers (where applicable), and SPID or EAZ (where applicable), to allow user selection if auto-detection fails. These can be implemented in the device or in the communications driver.

114. ISDN modem exposes both B channels

Recommended

ISDN modems should expose both B channels so that they can leverage the multilink PPP support included in the operating system.

Multilink PPP, as defined in RFC 1717, combines several ISDN B channels to increase the bandwidth of PPP links.

When using ISDN modems connected to the server using a single serial port, the capabilities included in the operating system cannot be leveraged and the users may not be able to fully benefit from the features in the ISDN device, such as supporting two B-channels and combining them into one fast link.

This is because Windows NT cannot see both B channels of the ISDN connection unless each B channel is exposed to the operating system, either as a COM port, or by way of NDIS.

External ISDN modems should be on a port fast enough to expose the full bandwidth of both B channels, such as USB. Providing two separate COM-port cables is not an acceptable solution.

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115. ISDN modem supports asynchronous-to-synchronous conversion

Required

These types of ISDN devices are treated as modems, not as internal ISDN devices supported using NDIS WAN miniports. In the external case, the primary implication is that the operating system will send byte-level PPP, also known as asynchronous PPP. In the NDIS WAN case, the implication is that the operating system will send bit-level PPP, also known as synchronous PPP.

Because ISDN is a synchronous service and an ISDN modem connects to an asynchronous port on the system, the device must provide some means of converting asynchronous data to synchronous data.

116. ISDN modem uses high-speed port

Recommended

Because of speed limitations inherent in a server's COM ports, the connection for ISDN modems should be high speed, such as USB or IEEE 1394. A specification for controlling an ISDN TA over USB is in development by the USB Communications Device Class working group.

117. ISDN modem driver supports unattended installation, with limitations

Required

Configuration of the dependent parameters, such as SPIDs and switch-type IDs, must be done using the ISDN Configuration Wizard included in the operating system.

Parallel ISDN Devices

This section defines general requirements for ISDN and specific requirements for ISDN terminal adapters.

118. Internal ISDN device meets network adapter requirements

Required

The driver must support NDIS 5.0. Only NDIS 5.0 miniport drivers and INF files are allowed for complete user-friendly installation and operation of the ISDN adapter. The following network adapter requirements must be met:

- #61, Adapter uses NDIS 5.0 [connection-oriented] miniport driver, with call manager support
- #65, Adapter automatically senses presence of functional network connection
- #67, Adapter can transmit packets from buffers aligned on any boundary
- #68, Adapter communicates with driver across any bridge
- #77, Device Bay network adapter meets requirements
- #78, PCI network adapters are bus masters
- #79, USB or IEEE 1394 network device complies with related device class specifications

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119. Internal ISDN device supports synchronous HDLC framing

Required

High-level data link control (HDLC) framing is a standard for sending synchronous data. Other framing methods are allowed if the miniport driver provides simple HDLC framed synchronous PPP packets to NDIS.

120. Internal ISDN device and driver support raw unframed synchronous B channel I/O

Required

The internal ISDN device and the driver must support raw unframed (non-HDLC) synchronous B channel I/O at 64 Kbps for each B channel, with each B channel individually accessible. This will enable H.320 and voice calls over ISDN without audio breakup.

For these raw interfaces, the direct path to each B channel must support synchronous transmission and reception of H.221 frames, which are of 20 ms duration. To achieve this without additional latency to H.221, there must be support for overlapped I/O buffers at intervals of less than or equal to 20 ms in each direction. As underruns or overruns cause degraded audio, hardware buffering must be adequate to prevent B channel underruns and overruns. For Windows NT 5.0, 20 ms is adequate.

This can be achieved by making buffering software configurable with adequate range to handle foreseeable real-world conditions. The miniport driver should make I/O completion callbacks to NDIS for each I/O buffer as soon as the I/O for that buffer is complete and should not coalesce or delay callbacks.

121. Driver for ISDN internal device supports unattended installation, with limitations

Required

Configuration of the dependent parameters, such as SPIDs and switch-type IDs, must be done using the ISDN Configuration Wizard included in the operating system.

122. ISDN device with U-interface includes built-in NT-1 capability

Recommended

Note: This recommendation applies only in the United States.

A network terminator (NT-1) splits the duplexed transmit and receive signals from the ISDN line into separate transmit and receive components. An ISDN device with a built-in NT-1 can connect directly to the ISDN line. However, doing so prevents other devices from being attached to the ISDN line because only one NT-1 can be connected to an ISDN line. If the ISDN device has a built-in NT-1, it also should have a connector for either analog phone or another ISDN device (S/T-interface), such as an ISDN phone.

Adding an analog (POTS) port or S/T-interface to the ISDN device delivers convenience to the SOHO market, allowing customers to use one ISDN line to

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meet all their telecommuting needs at minimal cost. Many customers do not want a separate analog or digital phone line for their fax machines, modems, or phone when ISDN can do this with a device that has a POTS port or S/T-interface.

123. Internal ISDN device has software-selectable terminating resistors

Required

If the ISDN device has an S/T-interface for connecting additional ISDN devices and has configurable terminating resistors, they must be software configurable. The software selectable resistors can be selected on or off. The default value of termination is on in North America, but off in all countries where phone companies unconditionally provide the termination.

IrDA Requirements for Communications

Infrared capabilities are neither required nor recommended on servers. If they are implemented, they must meet the requirements in this section.

The interface between Infrared Data Association (IrDA) hardware (framers) and the Windows IrDA stack is through NDIS 5.0 miniport drivers that adhere to the conventions described in *Infrared Extensions to the NDIS Version 4.0 Functional Specification*. The Windows NT IrDA stack expects that the hardware and NDIS drivers deal with framing, transparency, and error detection, and also support media sense and speed change commands. Miniport drivers are responsible for discarding incoming frames with bad cyclic redundancy checks. These frames must never be forwarded to the protocol.

124. Infrared device meets network adapter requirements

Required

The following network adapter requirements must be met:

- #61, Adapter uses NDIS 5.0 miniport driver
- #67, Adapter can transmit packets from buffers aligned on any boundary
- #77, Device Bay network adapter meets requirements
- #78, PCI network adapters are bus masters
- #79, USB or IEEE 1394 network device complies with related device class specifications

125. Infrared device supports both FIR and SIR

Required

All infrared devices must comply with approved IrDA specifications, including support for SIR and FIR data devices.

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126. IrDA hardware reports a unique Plug and Play ID sufficient to support unattended driver installation

Required

FIR Plug and Play hardware must report a unique Plug and Play ID that matches the combination of the chip set, transceiver, and any other system specific parameters, in order for the operating system to find and install the correct INF, and the associated driver for the IrDA hardware.

In the best case, the IrDA hardware has only one Plug and Play ID, associated INF file, and a miniport driver that can auto detect the transceiver type and other system specific parameters. This enables the installation and configuration of the hardware and the driver without any user intervention.

In other cases, for example, where the driver can not autodetect the transceiver type, or any other system specific parameters, a unique Plug and Play ID for each combination of the chip set and the transceiver type must be reported, and an associated driver and INF file describing the configuration parameters must be provided by the vendor for each combination.

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CHAPTER 5

Storage Device Requirements

This section summarizes the requirements for storage devices used with servers.

Tips for selecting high-performance storage components. For manufacturers who want to select high-performance components for server systems, the following are the design features to look for in storage components:

- System relies on the SCSI or Fibre Channel controller for primary storage.
- Controller supports bus mastering, which is a requirement in these guidelines.
- Disks support reduced latency and fast rotational speeds.
- Drivers are tuned for 32-bit performance; 32-bit alignments on the adapter interface have no 16-bit alignments on odd addresses.
- Components do not use ISA.
- SCSI differential devices must support DIFFSENS as described in SCSI-3.
- PCI burst mode reduces disk controller time spent on the PCI bus.

Storage Device General Requirements

This section presents general requirements for controllers and peripherals.

Note: It is recognized that OEMs supply systems with specific feature requirements to corporations, which can include providing servers that do not include any disks installed before shipping to a particular corporate client. However, the system must include at least the minimum required configuration for testing.

127. Non-ISA host controllers and devices support bus mastering

Required

Bus master capabilities must meet the related specification for the particular controller.

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The host controller must not use the ISA bus. An exemption exists for ISA-based, ATA-connected CD drives used solely for the purpose of installing software on a server system. Such devices cannot be used for any other purpose, including access to data by client systems.

Note: This requirement does not apply to legacy FDCs and will not become a requirement for the FDC in the future.

128. System and Option ROMs support Int 13h Extensions

Required

The Int 13h Extensions ensure correct support for high-capacity drives. Support for the fixed-disk access subset of Int 13h Extensions must be provided in the system BIOS and in any option ROMs for storage devices that include BIOS support. For information about the Int 13h Extension APIs, see the Windows NT 5.0 DDK.

Support for drives with capacities greater than 8.4 GB must be provided through the extended services—functions 4xh and greater—of the Int 13h Extensions as defined in *Information Technology Enhanced BIOS Services for Disk Drives* [T13-1226DT], Revision 7 or later, (available at ftp://fission.dt.wdc.com/pub/standards/x3t13/project/). The system BIOS should support the use of logical block addressing (LBA) from drives with LBA addressable area greater than 16,515,072 sectors.

Recommended: BIOS interrupt services should provide a protocol-independent method using the Int 40h extension to support ATAPI floppy drives as specified in the ARMD Specification, Version 1.0.

129. Block rewritable optical ATAPI device complies with SFF 8070i

Required

The SFF 8070i standard defines the requirements for block rewritable ATAPI devices (optical storage devices), including specifications for logical unit number (LUN) implementation, media status notification, and device write protection. This definition includes required support for the Read Format Capacities command.

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130. Controller and peripherals support media status notification

Required

The following list shows the required specifications for implementing media status notification, depending on device type.

Device type	Media status notification implementation
CD and DVD devices	Required. Comply with *ANSI NCITS T10 Multi-Media Command Set-2 (MMC-2)* standard for Media Status Event Notification.
ATA non-ATAPI removable storage devices	Required. Comply with *Media Status Notification, Version 1.03*.
ATAPI floppy/optical direct access drives	Required. Comply with either *ANSI NCITS T10 Multi-Media Command Set-2 (MMC-2)* standard for Media Status Event Notification or SFF 8070i Version 1.1.
Other ATA/ATAPI devices, including tape drives	Recommended. If implemented, comply with *Media Status Notification, Version 1.03* or SFF 8070i.
Other types of SCSI removable devices	Recommended. If implemented, support based on *NCITS Reduced Block Commands* (RBC; T10/97-260r0) standard is recommended.
IEEE 1394 storage devices	Required. Comply with *NCITS Reduced Block Commands* (RBC; T10/97-260r0) standard.

131. Operating system recognizes the boot drive in a multiple-drive system

Required

The implementation of boot-drive determination in multiple-drive systems is defined in Section 5.0 of the *Compaq, Intel, Phoenix BIOS Boot Specification, Version 1.01*. This is the format that Windows NT uses for determining the boot drive when new bootable devices are introduced for servers. The system designer can use an equivalent method for boot-drive determination, but the method must ensure that the boot drive is recognized by the Windows NT operating system.

132. USB-based mass storage device meets design guide requirements for USB

Required

If a USB-based mass-storage device (including tape, UHD floppy drive, and CD drive) is implemented in a server system, it must meet the requirements in this design guide and the requirements defined in *Universal Serial Buss Device Class Definition for Mass Storage Devices, Version 1.0* or later.

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133. IEEE 1394-based mass storage meets requirements

Required

If an IEEE 1394 storage device is implemented in a server system, it must meet any 1394 requirements in this design guide and must comply with *1394 Open Host Controller Interface Specification, Revision 1.0* (OpenHCI).

A removable IEEE 1394 mass storage device must not be the primary boot device.

SCSI Controllers and Peripherals

SCSI is a flexible I/O bus that is used in the design of a variety of peripherals, including disk drives, CD drives, tape drives, magneto-optical drives, and scanners. This section presents the requirements for SCSI hardware that is compatible with Windows NT, including adapters, peripherals, and any device that uses a SCSI controller.

134. System includes SCSI host controller and SCSI peripherals

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Required*	*Recommended*

Recommended: Fibre Channel, especially for servers running Windows NT Server/Enterprise Edition.

Note: Servers that implement Fibre Channel as the storage connection are not required to also provide SCSI capabilities.

The SCSI host adapter is the circuitry that serves as an interface between the system and one or more SCSI peripherals. A host adapter can be a card that plugs into the system's expansion bus, such as a PCI card, or it can be designed directly into the system board set.

The host controller must support PCI bus mastering, with bus mastering enabled by default.

135. SCSI controllers provide multi-initiator support if the controller provides external device connection capability for use as a cluster node

Required

Multi-initiator support allows two SCSI controllers—each installed in a separate computer system—to coexist on a shared SCSI bus with a set of shared devices.

For use in a system intended as a node in a cluster using shared SCSI, the SCSI IDs must be changeable from the default SCSI controller ID of 7, and the boot time SCSI bus reset operation must be able to be disabled on each controller attached to a shared bus.

For any SCSI controller with external connectors that is capable of being used as a node in a cluster, as described previously, the connector must be clearly labeled as

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available for cluster connections. This labeling must be positioned so that it is clearly visible to a user when attaching external devices to the affected external connector.

136. SCSI option ROMs support virtual DMA services

Required

Plug and Play SCSI host adapters must support virtual DMA services in the host-adapter option ROM, together with the required bus-mastering support. Virtual DMA supports scatter/gather capabilities, solving the problem of mapping linear addresses (segment:offset) into physical addresses.

137. Bus type is clearly indicated on connectors for all adapters, peripherals, cables, and terminators

Required

Connectors for each Fibre Channel or SCSI adapter, peripheral, cable, and terminator must be clearly labeled to show the bus type. All external SCSI connectors must display the appropriate SCSI icon defined in Small Computer Interface (SCSI-3) Parallel Interface (SPI) specification, Annex F, plus any clarifying abbreviations or acronyms. The following shows the related acronyms and their definitions:

- DIFF — Differential. A signal type used in external large storage cabinets.
- SGL — Single-ended. The most commonly used signal type, such as found in home PCs and high-end workstations.
- LVD — Low voltage differential. A signaling method similar to DIFF but with lower signaling voltages supporting higher transfer rates.

138. Differential devices support DIFFSENS as defined in SPI standard

Required

Without DIFFSENS, the differential bus drivers or a single-ended device will suffer fatal thermal damage if a single-ended device is put on a differential bus.

The specification for DIFFSENS is defined in Section 5.4.2 of the SPI standard.

139. Automatic termination circuit and SCSI terminators meet SCSI-3 specification

Required

Parallel SCSI add-on adapters and on-board controllers must use automatic termination that allows a user to add external devices without removing the server case. Terminators used in the SCSI host adapter must be regulated terminators, which are also known as active, SCSI-3 SPI, SCSI-2 alternative-2, or Boulay terminators. SCSI termination built onto internal cables must meet the SCSI-3 specification.

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140. Terminator power is supplied to the SCSI bus, with over-current protection

Required

The host adapter must supply terminator power (TERMPWR) to the SCSI bus for system-board implementations using PCI or another expansion bus. All terminators on the external SCSI bus must be powered from the TERMPWR lines in the SCSI bus.

In addition, the circuit that supplies TERMPWR must have overcurrent protection built into it. Devices that provide TERMPWR must also provide some means of limiting the current through use of a self-resetting device. For example, a positive-temperature coefficient device or circuit breaker can be designed into the circuit. These devices open during an over-current condition and close after the condition ends.

141. External connector meets SCSI-2 or later specification

Required

If an external connector is implemented, it must meet the requirements defined in SCSI-2 or a later specification.

142. Controller and peripherals implement SCSI data protection signal

Required

All SCSI peripherals and the SCSI host adapter must implement the SCSI bus data protection signal defined in the SPI standard, and data protection must be enabled by default.

143. SCSI connections use keyed and shrouded connectors

Required

For internal and external configurations, the SCSI bus cable must be plugged into shrouded and keyed connectors on the host adapter and devices. This ensures that the cable is properly positioned so the user cannot plug in cables incorrectly. For internal configurations, pin 1 orientation must be designated on one edge of the ribbon cable and also on the keyed connector for the SCSI peripheral device.

For an external configuration, the SCSI connector must not use the same connector type as any other non-SCSI connector on the system.

144. External devices use automatic termination, an external pluggable terminator, or an accessible on-board termination switch

Required

The recommended implementation for an external SCSI peripheral device is to provide automatic termination. In the absence of automatic termination, a mechanical means must be provided for setting termination and the switch must be accessible to the user without opening the server case or device chassis.

145. Shielded device connector meets SCSI-2 or later specification

Required

Device connectors must meet the specifications defined in SCSI-2 or later.

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146. SCAM support is disabled by default

Required

If SCAM support is present, it must be disabled by default. SCAM is not supported by the Windows NT operating system; enabling SCAM can cause the system to become unstable or inoperable.

147. Hardware supports the STOP/START UNIT command as defined in the SPI specification

Required

The hardware in SCSI peripherals must be able to fully recover from a software-initiated spin down without rebooting the system or cycling power. To properly support power management on SCSI drives and to ensure that the operating system responds to appropriate driver calls, be sure to correctly implement the STOP/START UNIT command as defined in the SPI (SCSI-3) standard.

148. STOP/START UNIT command can be used to decrease power consumption

Recommended

Wherever appropriate, for example, for storage disks, the STOP UNIT command can be used to decrease power consumption of the base platform.

149. SCSI devices that support hot-plugging meet design guide requirements

Required

To ensure reliable support for hot-plugging capabilities, the following requirements must be met by any SCSI devices that allow hot-plugging:

- **Hot-plugging for PCI devices uses ACPI-based methods.** Windows NT 5.0 supports dynamic enumeration, installation, and removal of devices connected by way of the PCI bus only if there is a supported hardware insert/remove notification mechanism as defined in Section 5.6.3 of the ACPI 1.0 specification.

  In order to properly function with the native support in the operating system, developing industry standards such as those referred to as PCI Hot Plug and Compact PCI must use ACPI-based methods for supporting hardware insertion and removal as defined in the ACPI 1.0 specification.

- **All removable media support media status notification.** Removable media must support the appropriate media status notification method to ensure that no loss of data or system failure results when such media is removed from the system. See requirement #130, “Controller and peripherals support media status notification.”

Recommended: A locking mechanism to ensure that devices are removed only under operating system control or during sleep or off states. For implementation details and additional design guidelines, see the article about hot-plugging support at http://www.microsoft.com/hwdev/busbios/rem_devs.htm.

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ATA Controllers and Peripherals

This section presents requirements for ATA hardware that is compatible with Windows NT, including adapters, peripherals, and any device that uses an ATA controller.

150. System does not include ATA host controller and peripherals

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Required*	*Recommended*

ATA disks should not be present in a server, and ISA-based ATA is not allowed for servers. If ATA is implemented in a system, the ATA host controller and peripheral must meet all related requirements for devices and drivers, and they must meet the requirements defined in this section.

A server running Windows NT Server/Enterprise Edition can use an ATA device only as a boot or installation device.

151. ATA controller and peripherals comply ATA/ATAPI-4 standards

Required

All ATA controllers and peripherals must meet the hardware and software design requirements listed in the current version of the *ATA/ATAPI-4 Revision 17* standard or later.

152. Dual ATA adapters use single FIFO with asynchronous access or dual FIFOs and channels

Required

PCI dual ATA adapters must be designed so that either channel can be used at any time; the operating system must not have to serialize access between the primary and secondary channel. Therefore, either the two channels are totally independent or a hardware arbitrator protects anything shared, such as a PIO read pre-fetch buffer.

A design implementing a single FIFO with a hardware solution to synchronize access to both channels meets this requirement if the design does not require that a request on one channel be completed before another can be started. A software-based solution is not acceptable.

ATA-based systems must be tested with ATA DMA enabled; the system must not have an embedded single-FIFO dual-channel ATA controller.

Section 5.0 of the *Compaq, Intel, Phoenix BIOS Boot Specification* defines the implementation for dual asynchronous channels.

Dual-channel controllers that require special software to serialize channel I/O for a single prefetch FIFO do not meet these requirements. Such designs require serial access to one of four devices, defeating the primary advantage of asynchronous

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dual-channel controllers. Furthermore, such devices are non-standard and require custom driver support.

153. System BIOS and devices support LBA if system uses ATA

Required

To enable support for ATA disk drives have capacities greater than 528 MB, the system BIOS must use LBA— the LBA bit in the Device/Head register must be set to one— for all read and write operations to the device. The ATA 1226 technical report defines the proper implementation of LBA.

Although ATAPI was defined to be transparent to the BIOS, the BIOS must recognize the presence of ATAPI devices using the signature defined in SFF 8020i.

154. System BIOS supports ARMD

Recommended

The system BIOS or option ROM should provide boot support for ATAPI bootable floppy disk drive in compliance with *ATAPI Removable Media BIOS Specification (ARMD), Version 1.0* or later. Complying with this specification provides Int13h and Int40h support for bootable floppy drives as the primary or secondary floppy device.

155. ATA controller and peripherals support Ultra-DMA

Required

All controllers and ATA peripherals must support Ultra DMA (also known as Ultra-ATA) at transfer rates up to 33 MB per second as defined in ATA/ATAPI-4 Revision 17. In addition to improved transfer rates, Ultra DMA also provides error checking for improved robustness over previous ATA implementations. PCI chip sets must implement DMA as defined in SFF 8038i.

ATA drives must comply with ATA-4, which defines the programming register set for PCI ATA bus master DMA, to ensure fully featured hardware and Windows-compatible device driver support.

Recommended support includes:

- Controller and peripherals support Ultra-DMA/66.
- Ultra DMA for ATAPI devices. If a device does not support the Ultra DMA transfer protocol, it must, at least, implement the termination scheme required by this protocol to ensure that all devices coexist with UDMA-33 devices.
- The system BIOS should configure the drive and host controller, optimized for Ultra DMA operation if possible, though the PIO mode must continue to work. The ACPI software should also support the restoration of these settings in ACPI control methods _GTM, _STM, and _GTF, for which there are no standard registers, if the controller loses timing context across a suspend and resume cycle. The BIOS pre-operating system boot disk services, INT13h read and write, need not actually use Ultra DMA for access to the drive prior to

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operating system boot. Definitions for the above ACPI control methods can be found in Section 5 of the ACPI 1.0 specification.

An exemption exists for ISA-based, ATA-connected CD drives used solely for the purpose of software installation on a server system. Such devices cannot be used for any other purpose, including access to data by client systems.

156. ATA controller and peripheral connections include Pin 1 cable designation with keyed and shrouded connectors

Required

Pin 1 orientation must be designated by one edge of the ribbon cable and also on the keyed connector of the ATA or ATAPI controller and peripheral device. Designation of the keyed connector must be clearly indicated on or near the connector.

157. ATAPI peripherals comply with ATA/ATAPI-4

Required

This standard defines standard hardware and software design guidelines for ATAPI devices. See also requirement #126, “System and Option ROMs support Int 13h Extensions.”

158. BIOS enumeration of all ATAPI devices complies with ATA/ATAPI-4

Required

This standard defines the enumeration process for all ATAPI devices.

159. ATAPI devices support DEVICE RESET command

Required

ATAPI devices must respond to the DEVICE RESET command regardless of their internal state, as defined in the ATA/ATAPI-4 standard. The controller can be reset by going into a power-on state (requests cleared, signature present), but any non-default mode values must be left in their current state with the DRV bit unchanged.

Devices that do not implement the PACKET command feature set, such as hard disk drives, must not implement the DEVICE RESET command.

160. ISA address ranges 3F7h and 377h are not claimed by ATA controllers

Required

To avoid having two devices in the system claim 3F7h and 377h, these addresses must not be claimed for device registers by ATA devices.

It is recognized that some FDC devices claim this range. Such devices can be implemented in a server system; however, the system manufacturer must ensure that only a single device in the system claims this range.

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161. ATA/ATAPI device supports ATA STANDBY command

Required

The ATA drive must implement the ATA STANDBY command according to the ATA standard. This command is defined in ATA/ATAPI-4.

The hard disk drive should spin up and be able to complete a Read operation within 10 seconds of applying power or leaving ATA STANDBY mode and transitioning to ATA ACTIVE, as specified in the *Storage Device Class Power Management Reference Specification, Version 1.0* or later.

Fibre Channel Controllers and Peripherals

This section presents requirements for Windows NT–compatible adapters, peripherals, and any devices that use Fibre Channel technology.

162. System includes Fibre Channel controller and peripherals

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Recommended*	*Recommended*
Enterprise:	*Recommended*	*Recommended*	*Recommended*
SOHO:	*Optional*	*Optional*	*Optional*

Fibre Channel is a technology for 1 gigabit per second data transfer that maps common transport protocols such as SCSI and IP, merging networking and high-speed I/O in a single connectivity technology. It is an open standard, defined by ANSI and OSI standards, that operates over copper and fiber-optic cabling at distances of up to 10 km.

If implemented on a server system, Fibre Channel must use the X3T11 Private Loop Direct Attach (PLDA) profile as the storage base to use the native Windows NT support. The Physical Layers implementation must comply with *Fibre Channel Physical* (FC-PH), *Revision 4.3* or later. For more information from the Fibre Channel Association, see the web site available at http://www.fibrechannel.com.

Erasable Disk Drives

This section presents the requirements for erasable disk drives provided with a server system or designed for use with Windows NT Server. This category includes 3.5-inch, 5.25-inch, and 12-inch magneto-optical or phase-change drives and media. It does not include CD, CD-R, CD-Rewritable, and DVD drives or media.

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163. SCSI erasable drives support SCSI commands

Required

The following commands or features must be supported by the device's driver:

- Erase (2C): full side and selected block erase
- Format requirements reported with Format command
- Mode Select: write cache disable
- Mode Sense: total spare blocks available, write protect status
- Prevent/Allow Medium Removal, Start/Stop Unit
- Read (28), Verify (2F)
- Reassign Blocks, Read Defect Data
- Reserve, Release
- Seek (SCSI CDB Opcode – 2B)
- Test Unit Ready, Request Sense, Read Capacity, Inquiry
- Write (2A), Write and Verify (2E)
- Write without pre-erase, for erasable optical only

Recommended: Inquiry with support for reporting serial number or other unique unit ID should be supported by the device's driver.

CD and DVD Drives

This section presents the requirements for CD and DVD drives.

164. System includes CD drive or other method for installing the operating system

Required

The server system must include either CD drive support or another method to enable the installation (or reinstallation) of the operating system. In a cluster, at least one node must have a CD drive.

CD Drive Requirements

This section summarizes requirements for CD drives. A CD drive is not required if another method is provided to support operating system installation. However, if a CD drive is present, it must comply with these requirements.

165. CD drive provides 8x or higher performance

Required

The CD drive must support 1200 KB per second average throughput or higher performance when running in the fully on power state. For recording CD drives, a write/read speed of 2x/8x or higher performance is required.

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166. CD drive is CD-Enhanced compatible

Required

The CD drive must be able to mount multisession CD-ROM discs, even if track 1 is Red Book audio. Microsoft recommends use of the Sony ReadTOC method for SCSI-2 multisession support, as noted in the MMC-2 standard.

CD-Enhanced support must comply with Blue Book standards, as defined in *Enhanced Music CD Specification, Version 1.0.*

167. CD drive supports specified logical and physical CD formats

Required

At a minimum, the CD device must be compatible with the following formats to ensure cross-media compatibility, based on compliance with the *Optical Storage Technology Association (OSTA) MultiRead Specification for CD-ROM, CD-R, CD-R/RW, and DVD-ROM Devices, Version 1.11*:

- Logical formats: CD Red Book (CD-Audio), Yellow Book (CD-ROM), Orange Book parts II and III (packet writing if recordable), White Book, Blue Book, and UDF version 1.5 and 2.0
- Physical formats: ROM (stamped), and Orange Book part II (CD-R) and part II (CD-RW)

Note: Any ATAPI CD drive designed to play back CD-I content must return a minimum of two track entries for the READ-TOC (0x43) command. These two track entries must be a track 01 entry and a track 0xAA entry for the lead-out address. Drives that do not comply with this minimum requirement cannot play back CD-I movies.

168. ATA/ATAPI CD drive complies with SFF-8020i, v. 2.6

Required

CD drives attached to the system using the ATA interface must support the hardware and protocols documented in the *ATA Packet Interface for CD-ROMs,* SFF-8020i, Version 2.6 or later.

Recommended: Support for the READ CD-DA command as defined in the MMC-2 standard.

169. CD drive supports multisession and compatibility forms of the READ_TOC command

Required

Both multisession forms (01b and 10b) as well as the compatibility form (00b) of the READ_TOC command, must be implemented. This requirement ensures complete support for CD multisession capabilities.

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170. ATA/ATAPI CD changer meets MMC-2 standard

Required

If an ATAPI-compatible CD changer is present that has a capacity for seven or fewer discs, the device must comply with MMC-2 standard.

171. System BIOS or option ROM supports El Torito No Emulation mode

Required

For server systems that include CD and DVD drives, the system BIOS or option ROM must support the No Emulation mode defined in *El Torito—Bootable CD-ROM Format Specification, Version 1.0*, published by IBM and Phoenix.

A removable USB mass storage device must not be the primary boot device.

172. CD drive uses push-to-close design

Recommended

A motorized design is not required, but if it is implemented, the device must be designed so the user has three options to close the device when inserting a disc:

- Physically push on the bay
- Physically push the close button on the bay housing
- Select a software-supported option to close the device

DVD Drive Requirements

This section summarizes requirements for supporting DVD drives. A DVD drive is not required in a server system, but if present, it must comply with these requirements. Systems targeted for use with Windows NT Server/Enterprise Edition should provide DVD drive capabilities.

For more information about DVD support under Windows NT, see the articles at http://www.microsoft.com/hwdev/dvd/.

173. DVD device provides 2x minimum transfer rate or better performance anywhere on the disk

Required

The minimum sustained DVD device media transfer rate must be at least 2 MB per second for read operations from the DVD disk.

Recommended: A 4x DVD-ROM at 4 MB per second sustained from the DVD disk.

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174. DVD drive and controller support bus master DMA transfers

Required

If DVD capability is present in a server, the drive and controller must support byte-aligned, multisegment, bus master DMA transfers.

If attached by way of an ATA interface, ATAPI DVD drives and ATA system-board implementations must support DMA as specified in ATA/ATAPI-4.

175. DVD drive meets minimum compatibility requirements

Required

DVD drives must support all the functionality of CD drives as outlined elsewhere in this document. Specifically, the DVD drive must be compatible with the following formats to ensure that the DVD drive can read earlier media:

- Logical formats: CD Red Book (CD-Audio), Yellow Book (CD-ROM), White Book, Orange Book parts II and III (packet writing), Blue Book, UDF Version 1.5 and 2.0, and DVD video, if applicable.
- Physical formats: ROM (stamped), Orange Book part II (CD-R) and part III (CD-RW), and ECMA-267 and ECMA-268 (DVD-ROM).

  Recommended: Support for ECMA-274 (PC+RW) and ECMA-272, 273 (DVD-RAM 1.0 and DVD-R).

Conforming to *OSTA MultiRead Specification, Version 1.11* indicates compliance with all of the above CD compatibility requirements.

176. DVD drive meets MMC-2 standard

Required

The MMC-2 standard defines the implementation requirements that the Windows NT operating system supports. A DVD drive must comply with the MMC-2 standard. Additionally, the drive must support the following commands:

Beh	Read CD	08h	Device reset
B9h	Read CD MSF	A0h	Packet
4Bh	Pause/resume	A1h	Identify packet device
E5h	Check power mode	Efh	Set features
90h	Execute device diagnostic	E6h	Sleep
E1h	Idle immediately	E0h	Standby immediate
00h	NOP		

DVD drives must also support the following:

- Timeout model as designed and documented in MMC-2.
- The Get Event Status command (Media Event Status class) and all related commands, including Persistent Prevent/Allow, as defined in MMC-2.

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- Get Configuration command for Morphing class devices (Class 2), as defined in MMC-2. Windows uses the Get Configuration command to determine whether media event status is supported correctly.

177. DVD drive uses push-to-close design

Recommended

A motorized design is not required, but if it is implemented, the device must be designed so the user has three options to close the device when inserting a disc:

- Physically push on the bay
- Physically push the close button on the bay housing
- Select a software-supported option to close the device

178. DVD drive supports defect management

Required

The drive must support the defect management that is transparent to the operating system, according to industry standards. Defect management for DVD-RAM media is defined in *DVD Specifications for Rewritable Disc, Part 1: Physical Specifications*, published by Toshiba Corporation. Defect management for DVD+RW is defined in ECMA-274.

179. System meets video playback requirements if DVD drive supports DVD-Video playback

Required

The following capabilities are required for DVD drives that support DVD-Video playback:

- **DVD drive supports copyright protection.** The drive must support a licensed content scramble system (CSS) copyright-protection scheme and provide support for CSS-protected discs to ensure proper protection for all content produced in accordance with CSS, as defined in *DVD Specification, Version 1.0* or later.

  Software is provided as part of the Windows NT operating system support for DVD to facilitate the authentication process required by this scheme, thus allowing a DVD drive to authenticate and transfer keys with a CSS decrypter. Operating system software acts as the agent to allow either hardware or software decrypters to be authenticated.

  Playback of regionalized movies must be handled in accordance with the CSS requirements and the interfaces as defined in the Mt. Fuji 2.0 specification for Phase II regionalization (RPC II). Version 2.0 of the Mt. Fuji specification will be proposed to the Small Form Factor committee as SFF 8090 Version 2.0 Revision 1.0. DVD implementations should conform to this specification if it is approved before these design guide requirements take effect.

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- **DVD decoder driver correctly handles media types, time discontinuity, and decode-rate adjustment.** This requirement specifies that the vendor-supplied minidrivers for DVD, MPEG-2, and AC-3 decoders have the following capabilities:
  - Use correct media types. This includes validating all format block fields on connection and on every IPin::QueryAccept message.
  - Query for IMediaSample2 on every received media sample to test for a time discontinuity bit. It is also acceptable to query on every video/audio frame to reduce CPU overhead.
  - Adjust decode rate in response to IPin::NewSegment() calls for video and subpicture.
- **DVD decoder supports subpicture compositing and closed captioning.** The system must be capable of displaying subpicture data as well as providing closed-captioning support for all such data stored on the disc. This requires YUV offscreen surface support, as defined later in this list.

  Subpicture streams must be supported as defined in the *DVD Specification, Version 1.0*, from Toshiba Corporation. Alpha blending, or a simulation implemented in the driver, is required for static menus.
- **Subpicture decoder correctly handles subpicture properties and other functions.** The minidriver for the subpicture decoder must be able to correctly handle the following:
  - Set the subpicture property
  - Turn subpicture compositing on and off
  - Set the highlight rect parameters

  For information, see the Microsoft DirectX® 5.1 SDK (provided in the Microsoft Platform SDK) and the DirectX 5.0 information in Windows NT 5.0 DDK.
- System supports seamless DVD-Video 1.0 navigation. This requirement includes menu navigation and video selection, and language and subpicture track selection to support the user's ability to navigate DVD-Video discs. Test sources include, but are not limited to, the following:
  - Matsushita Electronics Incorporated (MEI) test disc
  - Joe Kane Productions Video Essentials disc
  - Microsoft test disc

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- **MPEG-2 playback provides high-quality video output.** MPEG-2 solutions must provide high-quality video display output, as defined by the following:
  - Smooth frame delivery, with all video fields and frames from the MPEG source decoded.
  - Audio and video synchronized to within one and a half video frames, with synchronization not allowed to drift out over time.
  - No tearing - provide proper video buffering, such as double buffering.
  - Correct display of multiple aspect-ratio content. The material should be displayed according to the aspect ratio information in the MPEG header.

  This requires support for YUV offscreen surface and up/down interpolated scaling, as defined in the following requirement.
- **Graphics adapter supports DVD movie playback features.** Any system with a DVD drive that includes the ability to play back MPEG-2 data streams must meet the requirements listed here. However, this requirement does not apply for systems that include DVD drive for storage purposes but do not include DVD-Video playback software. The following capabilities are required for solutions that use either hardware or software MPEG-2 decoders:
  - Up and down scaling with bilinear interpolation. Recommended: 5 taps, both vertically and horizontally.
  - YUV 4:2:2 and 4:2:0 planar offscreen surface support.
  - VGA destination color keying for video rectangle.
  - AGP or PCI bus mastering.

Tape Drives

Tape drives as backup devices can be an important part of guaranteeing data availability at a corporate site. Windows NT Server includes a graphical tool named Backup that supports tape backup of Windows NT Server-based data.

If a tape drive is provided in a server system, it must comply with the requirements and recommendations in this section.

180. System includes tape drive for local backup

Recommended

System administrators will commonly want offline backup capabilities to be available. If a tape drive is provided with a server system, either as a built-in or peripheral add-on device, it must meet the minimum requirements defined in this section.

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181. Single-tape device meets minimum capacity requirements

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*4 GB required*	*4 GB required*	*4 GB required*
Enterprise:	*8 GB required*	*8 GB required*	*8 GB required*
SOHO:	*4 GB required*	*4 GB required*	*4 GB required*

Recommended: 8 GB minimum capacity for Basic and SOHO servers.

Minimum uncompressed, formatted storage capacity is required for any tape device designed to comply with these guidelines.

182. Single-tape device meets minimum speed requirements

20 MB/minute required

Minimum speed capabilities are required for any tape device designed to comply with these guidelines.

183. Tape device meets industry standards

Required

A SCSI tape peripheral must comply with the SCSI tape command set and with the requirements defined in "SCSI Controllers and Peripherals" earlier in this chapter.

ATA is not recommended for servers, but if an ATA tape peripheral is implemented, it must comply with the packet passing protocol defined in SFF 8020i, Version 1.2. Also, for cartridge drives, the device must comply with QIC 157, Revision D or later.

184. SCSI tape drive supports SCSI commands

Required

The following commands or features must be supported by the device's driver:

- Erase
- Mode Select—compression enable/disable
- Mode Sense—write protect status, media type, and density code reporting
- Prevent/Allow Medium Removal, Load/Unload Unit
- Read, Verify
- Reserve, Release
- Rewind, Space, ReadPosition, Locate
- Test Unit Ready, Request Sense, ReadBlockLimits, Inquiry
- Write, Write Filemarks

Recommended: Inquiry with support for reporting serial number or other unique unit ID should be supported by the device's driver.

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185. Win32-based backup solution provided with device

Required

For a tape device designed for Windows NT Server, the manufacturer must provide a Windows NT tape driver for the built-in Windows NT backup application or provide a Win32-based backup application for the device if the Windows NT Server operating system does not include built-in support for the tape drive.

A hardware vendor can also choose to include a backup application that provides additional functionality over that included in Windows NT Server, such as the ability to create and script jobs, automated scheduling of jobs, remote administration of backup, and client-server backup to remote tape devices.

Media Changers

This section defines requirements for media changers.

CD Changers

This section provides requirements for CD changers.

There is no requirement or recommendation for providing a CD changer with a server system, but if present or designed to be compatible with Windows NT 5.0, it must comply with these requirements.

186. CD changer for seven or fewer discs meets MMC-2 standard

Recommended

If an ATAPI-compatible CD changer is present that supports seven discs or less, the device should comply with the MMC-2 standard.

Tape and Optical Disk Changers

This section provides requirements for tape and optical disk changers. There is no requirement or recommendation for providing a tape or optical disk changer, but if a device is present or is designed to be compatible with Windows NT 5.0, it must meet the requirements defined in this section.

This includes changers that support the following drive/media types:

- 3.5-inch, 5.25-inch, and 12-inch magneto-optical or phase-change drives and media
- All magnetic tape drives and media

It does not include changers that support CD-ROM, CD-R, CD-Rewritable, or DVD drive/media types.

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187. SCSI changer and drive support auto-configuration

Required

To meet requirements for auto-configuration of changers and their associated drives, the following changer requirements and configuration restrictions are defined:

- For changers where autoconfiguration under Windows NT Media Services (NTMS) control is a targeted feature, all changer tape or optical disk drives must be connected to the same SCSI bus as the changer.

  Changer systems that are not configured this way will not be autoconfigurable under NTMS in Windows NT 5.0 and must provide documentation that describes the appropriate manual configuration process for use with NTMS. Examples of proper documentation are available in Appendix A of *NTMS Programmers Guide*, at http://www.highground.com/developer/documents/ntmsdocu.htm.
- The changer's Read Element Status–Data Transfer Element Descriptor must support the reporting of the SCSI Bus Address and LUN of each drive in the library unit.
- If drive cleaning is required and can be automated, a specific slot that is accessible by way of a Move Medium command must be designated in the Operator's Guide.
- The changer must be able to report if a bar-code reader is installed in the unit.
- The changer must be able to report on the current of (magazine) slots and drives by using the Read Element Status command.

188. SCSI tape and optical disk changers support SCSI commands

Required

The following commands or features must be supported by the changer:

- Initialize Element Status (with/without bar-code reading)
- Mode Sense—Pages 1D, 1E, 1F
- Move Medium
- Prevent/Allow Medium Removal (door access and IEPORT locking)
- Read Element Status
- Reserve, Release
- Send Volume Tag, Request Volume Element Address
- Test Unit Ready, Request Sense, Inquiry

Recommended: Inquiry with support for reporting serial number or other unique unit ID should be supported by the changer.

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CHAPTER 6

Physical Design and Hardware Security Requirements

This chapter summarizes physical design and hardware security requirements and recommendations.

Physical Design Requirements

This section presents the requirements related to the physical design of servers.

189. Icons are provided for all external connectors

Required

This requirement helps ensure that the end user can correctly make the physical connections required for adding a device to a system. This requirement includes the following:

- Wherever possible, keyed or shrouded connectors or other configurations should be used to prevent misconnection. The physical design of the connector must ensure that the user cannot mistakenly insert the connector into the wrong port.
- Icons are provided for all external connectors. The icons can be molded, printed, or affixed as permanent stickers, which can include text. Icons can be based on existing vendor designs or on the examples shown at http://www.microsoft.com/hwdev/desguid/icons.htm.
- Systems and peripherals must use a color-coding scheme for connectors and ports. The following list displays the recommendation for standard color coding of connectors and ports. The selection of these specific colors was done using criteria established by Human Factors and Industrial Design professionals from multiple companies who are involved in the design of computer hardware.

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Connector	Recommended color	Pantone
Analog VGA	Blue	661C
Audio line in	Light blue	284C
Audio line out	Lime	577C
Digital monitor/flat panel	White	
IEEE 1394	Grey	424C
Microphone	Pink	701C
MIDI/game	Gold	131C
Parallel	Burgundy	235C
PS/2-compatible keyboard	Purple	2715C
PS/2-compatible mouse	Green	3395C
Serial	Teal or Turquoise	322C
Speaker out/subwoofer	Orange	157C
Right-to-left speaker	Brown	4645C
USB	Black	426C
Video out	Yellow	123C
SCSI, network, telephone, modem, and so on	None	—

It is recommended that retail peripherals also implement color coding, and those that do are required to use the colors in order to correspond with servers that adopt this scheme.

Note: It is recognized that the design for legacy ports, such as the PS/2-compatible mouse and keyboard ports, analog audio and video jacks, and the microphone and speaker jacks, will not change and therefore cannot fully meet this requirement. However, icons and labels must be provided wherever possible to help the user make the correct connections.

190. All expansion slots in the system are accessible for users to insert cards

Required

The space for expansion cards that will reside in associated expansion slots cannot be physically blocked by components or devices provided with the system. However, this requirement does not exclude configurations that provide half-height cards for some slots, passive back planes for connectors, and so on. It is understood that in order to install expansion cards in some expansion slot implementations, users might have to temporarily move other system components to gain access to the slot. In general, designers should minimize this juggling as much as possible.

191. System and device design include protected switches

Recommended

Switches can be covered with a hood or other protection to prevent inadvertent switching. Locks can also be provided to prevent unauthorized access.

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192. System design includes locking case

Recommended

The computer case can be protected with key locks to prevent unauthorized access.

Other recommended features include:

- Key lock removes the computer case without additional tools—if this can be done while maintaining compliance with other safety standards.
- Software management of physical components as documented in *Windows Hardware Instrumentation Implementation Guidelines, Version 1.0* (WHIIG), which also defines the Windows-specific requirements of the *Wired for Management Baseline Specification, Version 2.0,* for hardware instrumentation.

193. System and device design include positive retention connectors

Recommended

Positive retention mechanisms should be implemented to ensure connections. The retention mechanism should be operated by hand, requiring no tools for mating and breaking the connection. It is recognized that certain legacy connector implementations, such as PS/2-compatible pointing devices and keyboards, will not generally allow this. However, locking cable connections provide a valuable feature for end users.

194. Parallel port design provides sufficient space for connector assembly

Required

The parallel port design must provide enough space between the connectors and the surrounding enclosure to allow for a mating connector, connector shell, and latch assembly. The IEEE 1284 specification recommends an IEEE 1284-C connector for all new ports and devices.

Hardware Security Requirements

This section summarizes the system hardware security requirements and recommendations.

A baseline measurement of a secure operating system is the U.S. National Security Agency's criteria for a C2-level secure system. The requirements for a C2 secure system are articulated by the U.S. Department of Defense's National Computer Security Center (NCSC) in the publication *Trusted Computer System Evaluation Criteria*, also known as the "Orange Book." All systems, whether they are network operating systems or stand-alone operating systems, are evaluated under the criteria set forth in the Orange Book.

Windows NT Server was designed to comply with the NCSC's Orange Book requirements. Every process and feature was designed with C2-level security in mind. Because the Windows NT Server C2 implementation is entirely software-

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based, users will not have to install additional hardware on either their servers or clients to meet C2-level security requirements. However, the hardware must meet minimum requirements for C2 evaluation with Windows NT. The C2 evaluation report is available in the following publication:

> *FINAL EVALUATION REPORT Microsoft Windows NT Workstation and Server Version 3.5 with U.S. Service Pack 3.* National Computer Security Center, 23 June 1995.

In addition to its C2 evaluation, both the base and the network components of Windows NT have received the F-C2, E3 ITSEC rating in the United Kingdom. This rating can be leveraged in Germany and soon in France and the Netherlands. Therefore, customers in both the U.S. and Europe can operate certifiably secure systems.

195. C2 evaluation for hardware

Recommended

C2-evaluated hardware meets requirements defined in the Orange Book.

For hardware designed for customers outside the U.S., equivalent evaluation might be defined in local standards, such as F-C2/E3 ratings in Europe.

196. Peripherals meet hardware security recommendations

Recommended

OEM-specific solutions can be implemented to meet these recommendations. The following hardware security features are recommended:

- External drive devices should have locking capabilities. Each removable media device on a server system should be capable of being locked to prevent unauthorized access to data. A single locked door covering the drives is sufficient. The locking mechanism must render the device useless, whether locking is done electronically or mechanically.
- Computer case and switches should have locking capabilities to prevent unauthorized internal access. An OEM-specific method can be implemented, either electronically or mechanically.
- Remote software management should be supported for physical components.
- Controls and remote alerts should be provided for chassis-open intrusion.

For servers running either Windows NT Server or Windows NT Server/Enterprise Edition, smart card readers and cards should be provided. If provided with a server system, smart card devices must be compatible with *Interoperability Specification for ICCs and Personal Computer Systems*, available at http://www.smartcardsys.com/doc/content.html.

In addition, smart card readers and device drivers must be Plug and Play-compliant and must adhere to the Microsoft Smart Card DDK for the Windows and Windows NT platforms, which will be provided in the Windows NT 5.0

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DDK. Smart card applications and service-provider DLLs must adhere to the Microsoft Smart Card SDK that is part of the Microsoft Platform SDK.

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CHAPTER 7

Reliability, Availability, and Serviceability Requirements

These requirements and recommendations relate to ease of use, ease of maintenance, manageability, and failure tolerance. Design guidelines that make server configuration, management, and servicing easier for end users and administrators are defined to help reduce the total cost of ownership for servers.

Reducing the total cost of ownership is an important goal for servers; a key priority in this effort for servers is minimizing downtime. This goal is achieved through mechanisms for backup and reliability, remote management, and emergency and preboot management.

Backup and Reliability Requirements

One of the most powerful characteristics of Windows NT Server is its reliability. Windows NT Server includes the following reliability and fault-tolerance capabilities:

- Automatic restart
- Complete tape backup support
- Error handling and protected subsystems
- Fault tolerance using disk mirroring, disk duplexing, and disk striping with parity (RAID 5)
- Recoverable file system, automatic replication of directory partitions, and support for Backup Directory Servers
- Uninterruptible power supply (UPS) support

The following sections define hardware requirements and recommendations for peripheral devices that support reliability and availability under Windows NT Server.

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Backup Hardware

This section defines the requirements for backup hardware for servers.

197. System includes integrated backup solution

Recommended

An integrated tape drive or other device should be included in the system. Although the recommended method to back up files on another server is to use a backup service under Windows NT Server, system administrators will commonly want offline backup capabilities to be available.

For information about hardware requirements related to backup capabilities, such as tape drives and so on, see Chapter 5, “Storage Device Requirements.”

Power Supply

This section defines the guaranteed power requirements for servers.

198. System includes UPS provided with system

Recommended

For servers deployed in many corporate environments, the more common choice will be to provide guaranteed power for the server room.

199. System includes power supply protection using N+1 (extra unit)

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Recommended*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Recommended*	*Recommended*

The system overvoltage/undervoltage protection and power supply switch-over circuitry should have the capability to regulate according to the system load. For each voltage used in the system, the output voltages of the redundant power supplies should be within the range of values that can guarantee the proper operation of the system, no matter which supply is active. Power-supply switch-over should occur swiftly enough to maintain normal server system operation.

200. System supports replacement of power supplies

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Required*	*Required*	*Required*
SOHO:	*Recommended*	*Required*	*Recommended*

Recommended: Hot-swapping capabilities for power supply replacement and power supply redundancy.

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201. System supports replacement of fans

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Optional*	*Required*	*Optional*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Optional*	*Required*	*Optional*

For highest reliability, hot-swap fans should be implemented to maximize server up time.

202. System includes local hot-swap power supply replacement indicators

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Required*	*Recommended*

Any system that provides hot-swap power supply replacement and power supply redundancy should have local indicators that unambiguously indicate the supplies that must be replaced. These indicators guide service personnel to replace the correct power supply. Automatic retention mechanisms that prevent incorrect supply removal also satisfy this guideline.

Fault-Tolerant Hardware

This section provides design guidelines for fault-tolerance features and capabilities.

203. System includes multiple hard drives

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Required*	*Recommended*

Recommended: Hot-swappable drives.

Bus mastering is required for the drive controllers. Use of multiple hard drives and controllers in a server system provides both performance and reliability benefits, therefore, it is recommended for server systems.

204. System includes intelligent RAID controller with adequate storage capacity

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Required*	*Required*	*Required*
SOHO:	*Optional*	*Required*	*Optional*

An intelligent RAID controller—where the controller itself has the capability to run the array management software locally rather than simply executing disk accesses for host-based array software—provides the benefit of reduced demands on the host processor or processors, thereby freeing those computing resources

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and allowing their use by other tasks. The intelligent RAID controller may be internal to the server chassis, or within an external drive enclosure.

If an intelligent RAID controller is provided in a system, it should be capable of handling sufficient amounts of disk storage to fulfill the needs of the targeted usage model for that server. These needs will vary based on the storage-intensive nature of the server's tasks.

205. System supports at least one of RAID 1, 5, or 1/0

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Required*	*Required*	*Required*
SOHO:	*Recommended*	*Required*	*Recommended*

RAID 1 and RAID 1/0 are recommended. RAID 5 is also acceptable. RAID 0 (for enhanced performance but no added reliability) is optional.

206. RAID support includes notification of failed drive

Required

If RAID support is implemented, notification of a failed drive must be provided by the disk subsystem, with notification sent to the system administrator.

207. RAID subsystem supports automatic replacement of failed drive

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Required*	*Required*	*Required*
Enterprise:	*Required*	*Required*	*Required*
SOHO:	*Recommended*	*Required*	*Recommended*

The RAID subsystem must provide automatic replacement of a failed drive by a standby disk and must rebuild lost data without interfering with system operations.

208. RAID subsystem supports manual replacement of failed drive

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Required*	*Required*	*Required*
SOHO:	*Recommended*	*Required*	*Recommended*

The RAID subsystem should provide for manual replacement of a failed drive without shutting down or halting the system. The subsystem should also allow lost data to be rebuilt without interfering with system operations beyond some decreased performance of drive array access.

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Serviceability Requirements

This section provides design guidelines for serviceability features and capabilities.

209. System includes protected forced NMI switch for system diagnosis

Recommended

The system should include a protected switch to force an NMI on a stalled system. This switch permits the system to perform a memory dump that can then be used for diagnosis of system failures. If implemented, this switch must be protected in such a way that only an authorized administrator can perform this action.

High Availability Requirements

This section summarizes the requirements for high availability.

Through ACPI and OnNow power management capabilities, Windows NT 5.0 allows more control of dynamic configuration changes and power state changes. These features help implementers in handling event-based issues such as lights that are keyed to system failures, pending failures, or system power states.

210. System includes alert indicators for occurrence of failure

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Required*	*Recommended*

Alert indicators should be provided that indicate hard failure. In addition to visual alerting mechanisms, a design can also provide software alerts such as paging, fax, or e-mail notifications.

The following are required sources of alert indicators for hard failures for systems running Windows NT Server/Enterprise Edition. These indicators are recommended for servers running other versions of Windows NT Server.

- Cooling fan malfunction
- Disk drive error
- N+1 power module failure

These sources of alert indicators for hard failures are recommended for all servers:

- Chassis cover open (intrusion)
- NMI, processor internal error, and time-out of watchdog timer

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211. Hot-swappable drive includes a local disk drive replacement indicator

Required

A hot-swappable drive must have a local indicator that shows which drive or drives are ready for replacement, facilitating the servicing process and improving reliability by reducing possible errors.

This indicator should be on the drive chassis, not on the screen. The Device Bay "eject" signal can be used to activate a replacement indicator. Designers can choose to use existing LEDs for dual purposes to fulfill this requirement, but the LED display should clearly show when a drive is ready for removal, as opposed to other information the display would normally provide.

For systems with multiple drives, an individual replacement indicator should be physically associated with each hot-swappable drive slot.

212. System includes alert indicators for imminence of failure

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Required*	*Recommended*

Alert indicators that indicate informative failure are required for Enterprise servers and should be provided for all servers. The hard failure and informative failure indicators cannot be on simultaneously. In addition to visual alerting mechanisms, a design can also provide software alerts such as paging, fax, or e-mail notifications.

The following are required sources of alert indicators for imminent failures for systems running Windows NT Server/Enterprise Edition. These are recommended for servers running other versions of Windows NT Server:

- Abnormal temperature of processor or inside chassis
- AC power line failure (operated by UPS)

Manageability Baseline Requirements

This section presents server requirements related to the Wired for Management (WfM) initiative and the Zero Administration initiative for Windows. The WfM initiative seeks to raise the level of management capabilities on mobile, desktop, and server platforms. The Zero Administration initiative seeks to ensure a controlled, highly manageable enterprise.

The baseline for these requirements is *Windows Hardware Instrumentation Implementation Guidelines, Version 1.0* (WHIIG), which also defines the Windows NT-specific requirements of the *Wired for Management Baseline Specification, Version 2.0*, for hardware instrumentation.

Collectively, the items in this section represent the "Manageability Baseline" requirements.

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Tips for implementing management capabilities. For manufacturers who want to implement management capabilities for server systems and components, these are the design steps to pursue:

- Implement the recommended component instrumentation features defined for servers in *Windows Hardware Instrumentation Implementation Guidelines*.
- For those components that require Windows Management Instrumentation (WMI), ensure that WMI is enabled in device minidrivers as defined in the Windows NT 5.0 DDK.
- Refer to WHIIG for other driver requirements and design tips.
- For all instrumented components, test against the baseline features required in WHIIG.
- For each component, extend the WBEM and CIM schemas to expose the device's custom features in any CIM-ready management browser.

General Manageability Baseline Requirements

This section defines requirements related to centralized control and configurability and BIOS support for system manageability.

213. Remote new system setup and service boot support uses DHCP and TFTP

Recommended

The complete mechanism for remote new system setup is defined in *Network PC System Design Guidelines, Version 1.0b* or later.

If implemented, there must be a way for this capability to be enabled or disabled by way of administrative control to maintain server security.

See also the requirement for the preboot execution environment in requirement #11, "System BIOS meets boot support requirements."

214. Expansion devices can be remotely managed

Recommended

Devices provided as expansion devices should be capable of being remotely managed, ensuring that control and TCO policies can be realized. The requirements for remote management capabilities are defined in "Manageability Component Instrumentation Requirements" later in this chapter.

For example, for any implementation of a floppy drive, the floppy drive should be capable of being remotely disabled as a boot selection and should be able to be locked.

Certain devices are not required to have remote disabling capabilities, including the primary hard disk drive, the network adapter, and any standard devices that use legacy connections, such as a keyboard or pointing device that uses a PS/2 connection. However, it must be possible to use permissions, policies, or other

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methods to remotely manage capabilities such as hard disk access or to control certain users' ability to change the MAC address or configuration settings for the network adapter.

If implemented, there must be a way to enable and disable this capability by way of administrative control to maintain server security.

See also the requirement for the BIOS to ensure secure preboot access to hardware components in requirement #11, "System BIOS meets boot support requirements."

Manageability Component Instrumentation Requirements

Platform management information requirements are defined for two key areas:

- Component instrumentation: Interfaces through which information is supplied by platform management components.
- Management information providers: Interfaces used by applications to access platform management information.

215. System supports Windows hardware instrumentation implementation guidelines

Required

These guidelines are defined in *Windows Hardware Instrumentation Implementation Guidelines, Version 1.0*.

216. System includes driver support for WMI

Required

Requirements and recommendations related to implementing WMI for Windows NT 5.0 are defined in WHIIG.

Support for Windows hardware instrumentation, CIM, and Win32 extension schema objects and data must be implemented as defined in WHIIG.

217. Management information service provider enabled by default

Required

The management information service providers must be enabled on servers as defined in WHIIG.

Also, newly developed applications for managing WBEM-capable systems must comply with the appropriate CIM schema specifications and Windows application programming models.

218. SMBIOS 2.1 or later static table support provided

Recommended

Windows NT 5.0 will be able to surface SMBIOS 2.1 static table data into WBEM. System designers can provide platform-specific static information at boot time using this mechanism.

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APPENDIX A

Server Requirements Checklist

This appendix summarizes all the requirements listed for server systems in this guide. If a recommended feature is implemented, it must meet the requirements defined in this guide for that feature.

1. All operating system–controlled hardware complies with these guidelines and is listed on the Windows NT HCL
Required

2. System and components support dates from the year 2000 and beyond
Required

3. System processor capabilities meet performance requirements for each server class
Required

4. Multiprocessor-capable systems comply with symmetric multiprocessor support specifications and meet minimum expansion requirements
Required for all systems, with Enterprise class supporting expansion to at least 4 processors

5. Installed system memory meets minimum requirements

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*128 MB required*	*256 MB required*	*128 MB required*
Enterprise:	*128 MB required*	*256 MB required*	*128 MB required*
SOHO:	*128 MB required*	*256 MB required*	*128 MB required*

6. System memory capacity meets minimum requirements

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*512 MB required*	*2 GB required*	*512 MB required*
Enterprise:	*512 MB required*	*4 GB required*	*512 MB required*
SOHO:	*512 MB required*	*2 GB required*	*512 MB required*

7. System memory includes ECC memory protection
Required

8. System design meets ACPI 1.0 and related requirements
Required for all server types, with additional requirements for SOHO servers

9. Hardware design supports OnNow initiative
Required for all server types, with additional requirements for SOHO servers

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10. System startup meets requirements for OnNow support

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Optional*	*Optional*	*Optional*
Enterprise:	*Optional*	*Optional*	*Optional*
SOHO:	*Required*	*Required*	*Required*

11. System BIOS meets boot support requirements
Required

12. System and device configuration meet Plug and Play requirements
Required

13. Unique Plug and Play ID is provided for each system device and add-on device
Required

14. Option ROMs meet Plug and Play requirements
Optional

15. "PNP" vendor code is used only to define a legacy device's Compatible ID
Required

16. Device Bay controller and devices, if present, meet Device Bay 1.0 and other requirements
Required

Bus and Device Requirements

17. System provides an I/O bus based on industry standard specification
Required

18. System supports a 32-bit bus architecture
Required

19. System supports a 64-bit bus architecture

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Recommended*	*Optional*
Enterprise:	*Recommended*	*Required*	*Optional*
SOHO:	*Recommended*	*Recommended*	*Optional*

20. PCI bus and devices comply with PCI 2.1 and other requirements
Required

21. System makes a best effort to provide each PCI slot and device type access to a non-shared interrupt line
Required

22. System does not contain ghost devices
Required

23. System uses standard method to close BAR windows on nonsubtractive decode PCI bridges
Required

24. PCI devices do not use the <1 MB BAR type
Required

25. PCI devices decode only their own cycles
Required

26. VGA-compatible devices do not use non-video I/O ports
Required

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27. PCI chip sets support Ultra DMA if primary host controller uses ATA

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Required*	*Not applicable*	*Required*
Enterprise:	*Required*	*Not applicable*	*Required*
SOHO:	*Required*	*Not applicable*	*Required*

28. Functions in a multifunction PCI device do not share writable PCI Configuration Space bits
Required

29. Devices use the PCI Configuration Space for their Plug and Play identifiers
Required

30. Device IDs include PCI Subsystem IDs
Required

31. Configuration Space is correctly populated
Required

32. Interrupt routing is supported using ACPI
Required

33. BIOS does not configure I/O systems to share PCI interrupts

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Required*	*Recommended*

34. BIOS configures boot device IRQ and writes to the interrupt line register
Required

35. Systems that support hot swapping for any PCI device use ACPI-based methods
Required

36. All 66-MHz and 64-bit PCI buses in a server system comply with PCI 2.1 and other requirements
Required

37. All PCI devices complete memory write transaction (as a target) within specified times
Required

38. All PCI components comply with PCI Bus Power Management Interface specification

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Recommended*	*Recommended*
Enterprise:	*Recommended*	*Recommended*	*Recommended*
SOHO:	*Required*	*Required*	*Required*

39. System provides support for 3.3Vaux if system supports S3 or S4 state

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Recommended*	*Recommended*
Enterprise:	*Recommended*	*Recommended*	*Recommended*
SOHO:	*Required*	*Required*	*Required*

40. PCI bus power states are correctly implemented

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Recommended*	*Recommended*
Enterprise:	*Recommended*	*Recommended*	*Recommended*
SOHO:	*Required*	*Required*	*Required*

41. All USB hardware complies with USB 1.0 specifications
Required

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42. USB connections use USB icon
Required

43. USB devices and drivers support maximum flexibility of hardware interface options
Required

44. USB host controller complies with OpenHCI or UHCI specification
Required

45. System and devices comply with USB power management requirements
Required

46. USB devices comply with their related USB device class specifications
Required

47. USB hubs comply with the USB Specification, Version 1.1
Recommended

48. Bus-powered USB hubs provide ports that can be individually power switched
Required

49. Any subsystems implementing I_2O comply with standards and other requirements
Required

50. System does not include ISA expansion slots
Required

51. System does not include embedded ISA network adapters, storage controllers, or graphics adapters
Required

52. System does not include ISA expansion devices
Required

53. System includes APIC support
Required

54. Device driver and installation meet Hardware Design Guide requirements
Required

55. Keyboard and mouse connections meet requirements for bus and device classes
Required

56. Serial port meets requirements for bus and device classes
Required

57. Parallel port meets requirements for bus and device classes
Required for all server types, with ECP support required for SOHO servers

58. System includes emergency repair support
Required

59. Primary graphics adapter meets minimum requirements
Required

Networking and Communications Requirements

60. System includes non-ISA NDIS 5.0 network adapter
Required

61. Network adapter uses NDIS 5.0 miniport driver
Required

62. NDIS 5.0 miniport driver supports high-performance send and receive calls
Required

63. Network adapter offloads TCP/IP checksum, IP Security encryption, and TCP message segmentation
Recommended

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64. Full-duplex adapter automatically detects and switches to full-duplex mode
Required

65. Adapter automatically senses presence of functional network connection
Required

66. Adapter automatically senses transceiver type
Required

67. Adapter can transmit packets from buffers aligned on any boundary
Required

68. Adapter communicates with driver across any bridge
Required

69. Adapter supports filtering for at least 32 multicast addresses
Required

70. Adapter supports configuration capabilities and registry settings for performance tuning
Required

71. Server network adapter supports remote system setup capabilities
Recommended

72. Network connections used for remote boot meet Net PC v.1.0b requirements for remote system setup
Required

73. PCI network adapter properly supports higher-level PCI commands
Required

74. Adapter and driver support promiscuous mode
Required

75. Adapter and driver support multicast promiscuous mode
Required

76. Network adapter and driver support priority for IEEE 802-style networks
Recommended

77. Device Bay network adapter meets requirements
Required

78. PCI network adapters are bus masters
Required

79. USB or IEEE 1394 network device complies with related device class specifications
Recommended

80. Network device and driver meet Plug and Play and power management requirements.
Required

81. Network communications device supports wake-up events
Recommended

82. System includes modem communications device
Recommended

83. Modem supports ITU-T V.250, Hayes-compatible command set
Required

84. Data modem supports PCM (V.90) with V.42 and V.42bis protocol
Required

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85. Data modem supports digital connection to support host-side V.90 operation

	Windows NT Server	Enterprise Edition	Small Business Server
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Required*	*Required*	*Required*
SOHO:	*Recommended*	*Required*	*Recommended*

86. Fax modem supports 14.4 Kbps (V.17) with Class 1 (TIA-578-A) command set
Required

87. Fax modem supports adaptive DATA/FAX call classification based on T.32 +FAA
Required

88. Data modem supports V.80 for synchronous access
Required

89. Modem supports adaptive connection, V.25, V.8, and V.8bis call control signaling with V.251 modem commands
Required

90. Modem supports blacklisted and delayed number clearing
Required where applicable

91. Modem supports TDD, meeting V.18-1996 with V.250 AT commands
Recommended

92. Modem controller meets minimum requirements
Required

93. Voice modem support is provided

	Windows NT Server	Enterprise Edition	Small Business Server
Basic Server:	*Optional*	*Optional*	*Optional*
Enterprise:	*Optional*	*Optional*	*Optional*
SOHO:	*Recommended*	*Recommended*	*Recommended*

94. Voice modem supports ITU V.253 (AT+V)
Required

95. ATM adapter meets network adapter requirements
Required

96. ATM adapter supports a minimum number of simultaneous connections
Required

97. ATM adapter supports all service types defined by the ATM Forum

	Windows NT Server	Enterprise Edition	Small Business Server
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Required*	*Recommended*

98. ATM adapter supports UBR service type
Required

99. ATM adapter supports a minimum number of simultaneously active VBR or CBR connections
Required

100. ATM adapter supports traffic shaping
Required

101. ATM adapter enforces PCR on UBR virtual circuits
Required

102. ATM adapter and driver support dynamic link speed configuration
Required

103. ATM adapter supports OAM
Required

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104. ATM adapter supports buffer chaining (Tx + Rx)
Required

105. ADSL device is implemented as an integrated ADSL modem
Recommended

106. Integrated ADSL modem meets network adapter requirements
Required

107. ATM/ADSL solution is implemented for integrated ADSL modems
Recommended

108. ADSL modem supports DMT line encoding
Recommended

109. ADSL modem supports rate adaptation
Recommended

110. Device is implemented as an integrated cable modem
Recommended

111. Integrated cable modem meets network adapter requirements
Required

112. Integrated cable modem exposes an ATM or Ethernet interface
Required

113. ISDN modem supports required command set
Required

114. ISDN modem exposes both B channels
Recommended

115. ISDN modem supports asynchronous-to-synchronous conversion
Required

116. ISDN modem uses high-speed port
Recommended

117. ISDN modem driver supports unattended installation, with limitations
Required

118. Internal ISDN device meets network adapter requirements
Required

119. Internal ISDN device supports synchronous HDLC framing
Required

120. Internal ISDN device and driver support raw unframed synchronous B channel I/O
Required

121. Driver for ISDN internal device supports unattended installation, with limitations
Required

122. ISDN device with U-interface includes built-in NT-1 capability
Recommended

123. Internal ISDN device has software-selectable terminating resistors
Required

124. Infrared device meets network adapter requirements
Required

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125. Infrared device supports both FIR and SIR
Required

126. IrDA hardware reports a unique Plug and Play ID sufficient to support unattended driver installation
Required

Storage Device Requirements

127. Non-ISA host controllers and devices support bus mastering
Required

128. System and Option ROMs support Int 13h Extensions
Required

129. Block rewritable optical ATAPI device complies with SFF 8070i
Required

130. Controller and peripherals support media status notification
Required

131. Operating system recognizes the boot drive in a multiple-drive system
Required

132. USB-based mass storage device meets design guide requirements for USB
Required

133. IEEE 1394-based mass storage meets requirements
Required

134. System includes SCSI host controller and SCSI peripherals

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Required*	*Recommended*

135. SCSI controllers provide multi-initiator support if the controller provides external device connection capability for use as a cluster node
Required

136. SCSI option ROMs support virtual DMA services
Required

137. Bus type is clearly indicated on connectors for all adapters, peripherals, cables, and terminators
Required

138. Differential devices support DIFFSENS as defined in SPI standard
Required

139. Automatic termination circuit and SCSI terminators meet SCSI-3 specification
Required

140. Terminator power is supplied to the SCSI bus, with over-current protection
Required

141. External connector meets SCSI-2 or later specification
Required

142. Controller and peripherals implement SCSI data protection signal
Required

143. SCSI connections use keyed and shrouded connectors
Required

144. External devices use automatic termination, an external pluggable terminator, or an accessible on-board termination switch
Required

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145. Shielded device connector meets SCSI-2 or later specification
Required

146. SCAM support is disabled by default
Required

147. Hardware supports the STOP/START UNIT command as defined in the SPI specification
Required

148. STOP/START UNIT command can be used to decrease power consumption
Recommended

149. SCSI devices that support hot-plugging meet design guide requirements
Required

150. System does not include ATA host controller and peripherals

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Required*	*Recommended*

151. ATA controller and peripherals comply ATA/ATAPI-4 standards
Required

152. Dual ATA adapters use single FIFO with asynchronous access or dual FIFOs and channels
Required

153. System BIOS and devices support LBA if system uses ATA
Required

154. System BIOS supports ARMD
Recommended

155. ATA controller and peripherals support Ultra-DMA
Required

156. ATA controller and peripheral connections include Pin 1 cable designation with keyed and shrouded connectors
Required

157. ATAPI peripherals comply with ATA/ATAPI-4
Required

158. BIOS enumeration of all ATAPI devices complies with ATA/ATAPI-4
Required

159. ATAPI devices support DEVICE RESET command
Required

160. ISA address ranges 3F7h and 377h are not claimed by ATA controllers
Required

161. ATA/ATAPI device supports ATA STANDBY command
Required

162. System includes Fibre Channel controller and peripherals

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Recommended*	*Recommended*
Enterprise:	*Recommended*	*Recommended*	*Recommended*
SOHO:	*Optional*	*Optional*	*Optional*

163. SCSI erasable drives support SCSI commands
Required

164. System includes CD drive or other method for installing the operating system
Required

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165. CD drive provides 8x or higher performance
Required

166. CD drive is CD-Enhanced compatible
Required

167. CD drive supports specified logical and physical CD formats
Required

168. ATA/ATAPI CD drive complies with SFF-8020i, v. 2.6
Required

169. CD drive supports multisession and compatibility forms of the READ_TOC command
Required

170. ATA/ATAPI CD changer meets MMC-2 standard
Required

171. System BIOS or option ROM supports El Torito No Emulation mode
Required

172. CD drive uses push-to-close design
Recommended

173. DVD device provides 2x minimum transfer rate or better performance anywhere on the disk
Required

174. DVD drive and controller support bus master DMA transfers
Required

175. DVD drive meets minimum compatibility requirements
Required

176. DVD drive meets MMC-2 standard
Required

177. DVD drive uses push-to-close design
Recommended

178. DVD drive supports defect management
Required

179. System meets video playback requirements if DVD drive supports DVD-Video playback
Required

180. System includes tape drive for local backup
Recommended

181. Single-tape device meets minimum capacity requirements

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*4 GB required*	*4 GB required*	*4 GB required*
Enterprise:	*8 GB required*	*8 GB required*	*8 GB required*
SOHO:	*4 GB required*	*4 GB required*	*4 GB required*

182. Single-tape device meets minimum speed requirements
20 MB/minute required

183. Tape device meets industry standards
Required

184. SCSI tape drive supports SCSI commands
Required

185. Win32-based backup solution provided with device
Required

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186. CD changer for seven or fewer discs meets MMC-2 standard
Recommended

187. SCSI changer and drive support auto-configuration
Required

188. SCSI tape and optical disk changers support SCSI commands
Required

Physical Design and Hardware Security Requirements

189. Icons are provided for all external connectors
Required

190. All expansion slots in the system are accessible for users to insert cards
Required

191. System and device design include protected switches
Recommended

192. System design includes locking case
Recommended

193. System and device design include positive retention connectors
Recommended

194. Parallel port design provides sufficient space for connector assembly
Required

195. C2 evaluation for hardware
Recommended

196. Peripherals meet hardware security recommendations
Recommended

Reliability, Availability, and Serviceability Requirements

197. System includes integrated backup solution
Recommended

198. System includes UPS provided with system
Recommended

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199. System includes power supply protection using N+1 (extra unit)

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Recommended*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Recommended*	*Recommended*

200. System supports replacement of power supplies

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Required*	*Required*	*Required*
SOHO:	*Recommended*	*Required*	*Recommended*

201. System supports replacement of fans

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Optional*	*Required*	*Optional*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Optional*	*Required*	*Optional*

202. System includes local hot-swap power supply replacement indicators

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Required*	*Recommended*

203. System includes multiple hard drives

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Required*	*Recommended*

204. System includes intelligent RAID controller with adequate storage capacity

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Required*	*Required*	*Required*
SOHO:	*Optional*	*Required*	*Optional*

205. System supports at least one of RAID 1, 5, or 1/0

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Required*	*Required*	*Required*
SOHO:	*Recommended*	*Required*	*Recommended*

206. RAID support includes notification of failed drive
Required

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207. RAID subsystem supports automatic replacement of failed drive

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Required*	*Required*	*Required*
Enterprise:	*Required*	*Required*	*Required*
SOHO:	*Recommended*	*Required*	*Recommended*

208. RAID subsystem supports manual replacement of failed drive

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Required*	*Required*	*Required*
SOHO:	*Recommended*	*Required*	*Recommended*

209. System includes protected forced NMI switch for system diagnosis
Recommended

210. System includes alert indicators for occurrence of failure

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Required*	*Recommended*

211. Hot-swappable drive includes a local disk drive replacement indicator
Required

212. System includes alert indicators for imminence of failure

	Windows NT Server	*Enterprise Edition*	*Small Business Server*
Basic Server:	*Recommended*	*Required*	*Recommended*
Enterprise:	*Recommended*	*Required*	*Recommended*
SOHO:	*Recommended*	*Required*	*Recommended*

213. Remote new system setup and service boot support uses DHCP and TFTP
Recommended

214. Expansion devices can be remotely managed
Recommended

215. System supports Windows hardware instrumentation implementation guidelines
Required

216. System includes driver support for WMI
Required

217. Management information service provider enabled by default
Required

218. SMBIOS 2.1 or later static table support provided
Recommended

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Glossary

See also the Hardware Glossary available on http://www.microsoft.com/hwdev/glossary.htm.

Acronyms and Abbreviations

ABR available bit rate

ACE access control entry

ACPI Advanced Configuration and Power Interface

ADA Americans with Disabilities Act

ADSL Asymmetric Digital Subscriber Line

ANSI American National Standards Institute

API application programming interface

APIC Advanced Programmable Interrupt Controller

ARC Advanced RISC Computing

ASCII American Standard Code for Information Interchange

ASIC application-specific integrated circuit

AT IBM registered trademark for PC/AT

ATA AT Attachment

ATAPI ATA Packet Interface

ATM asynchronous transfer mode

BAR base address register

BDA BIOS Data Area

BIOS basic I/O system

bps bits per second

CBR constant bit rate

CHAP challenge handshake authentication protocol

CID Compatible ID

CIM Common Information Model

CISC complex instructions set computers

CMOS complementary metal-oxide semiconductor

COM 1. Component Object Model; 2. legacy serial port.

CSS copy scramble system

DAC digital-to-analog converter

DCE Data Communications Equipment

DDK device driver kit

DHCP Dynamic Host Configuration Protocol

DLL dynamic link library

DMA direct memory access

DMI Desktop Management Interface

DMTF Desktop Management Task Force

DSVD digital simultaneous voice/data

ECC error correction code

ECP extended capabilities port

EDT European Deaf Telephone

EIDE Enhanced Integrated Device Electronics

EISA extended ISA

EPP enhanced parallel port

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ESCD Extended System Configuration Data

ETSI European Telecommunications Standards Institute

FCD floppy disk controller

FC-PH *Fibre Channel Physical, Revision 4.3*

FIFO first in/first out

FSK Frequency Shift Keyed

GB gigabyte

GSM global system for mobile communications

HAL hardware abstraction layer

HCL Hardware Compatibility List

HCT Hardware Compatibility Tests

HDLC high-level data link control

HID Human Interface Device

HMMP HyperMedia Management Protocol

HSM hierarchical storage management

Hz Hertz

IDE Integrated Device Electronics

IEEE Institute of Electrical and Electronics Engineers

IETF Internet Engineering Task Force

IHV independent hardware vendor

I/O input/output

IOCTL I/O control

IP Internet Protocol

IPX/SPX Internetwork Packet Exchange/Sequenced Packet Exchange protocol

IRP I/O request packet

IRQ interrupt request

ISA Industry Standard Architecture

ISDN Integrated Service Digital Network

I_2O Intelligent I/O

ITU International Telecommunications Union

LAN local area network

LBA logical block addressing

LED light-emitting diode

LPT line printer

LSI large-scale integration

L2 Level 2

LUN logical unit number

MAC Media Access Control

MB megabyte

Mb/s megabits per second

MSCS Microsoft Cluster Server

MDK Modem Developers Kit

MEI Matsushita Electronics Incorporated

ms millisecond

MSDN Microsoft Developer Network

NCSC National Computer Security Center

NDIS Network Driver Interface Specification

NetBEUI NetBIOS Extended User Interface

NIUF National ISDN User's Forum

NMI Nonmaskable Interrupt

NTMS Windows NT Media Services

OAM operation and maintenance

OEM original equipment manufacturer

OpenHCI Open Host Controller Interface

OSI Open System Interface

PCI Peripheral Component Interconnect

PCI 2.1 *PCI Local Bus Specification, Revision 2.1*

PCM pulse coded modulation

PIO programmed I/O

PLDA Private Loop Direct Attach

POST power-on self-test

PPP point-to-point protocol

PS/2 Personal System/2

PTT Post, Telephone, and Telegraph

QIC Quarter-Inch Cartridge

QoS Quality of Service

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RADSL rate adaptive digital subscriber line

RAID retrieval and information database

RAM random access memory

RFC Request for Comments

RISC reduced instruction set computing

ROM read-only memory

rt real time

SCSI small computer system interface

SDK software developers kit

SFF Small Form Factor

SIG Special Interest Group

SMART Self-Monitoring, Analysis, and Reporting Technology

SMP symmetric multiprocessing

SNMP Simple Network Management Protocol

SOHO small office/home office

SPID service profile identifier

STS/EN Status and Enable bits (ACPI)

SVGA Super VGA

TAPI Telephony Application Program Interface

TB terabyte

TCO total cost of ownership

TCP/IP Transmission Control Protocol/ Internet Protocol

TDD Telephone Device for the Deaf

TFTP Trivial File Transfer Protocol

UART Universal Asynchronous Receiver/Transmitter

UBR unspecified bit rate

UDF universal disk format

UHCI Universal Host Controller Interface

Unimodem universal modem driver

UPS uninterruptible power supply

USB Universal Serial Bus

VAR value-added retailer

VBR variable bit rate

VC virtual channel

VCI virtual channel identifier

VDM virtual device manager

VGA video graphics array

VPI virtual path identifier

WBEM Web-Based Enterprise Management

WDL Windows Driver Library

WDM Windows Driver Model

WfM Wired for Management

WHQL Windows Hardware Quality Laboratory

WMI Windows Management Instrumentation

Hardware Glossary

A

ACPI Advanced Configuration and Power Interface. A specification that defines a new interface to the system board that enables the operating system to implement operating system–directed power management and system configuration. Following the ACPI allows system manufacturers to build systems consistent with the OnNow design initiative for instantly available PCs.

ACPI hardware Computer hardware with the features necessary to support operating system power management and with the interfaces to those features described using the Description Tables as specified in *Advanced Configuration and Power Interface Specification*.

add-on devices Devices that are traditionally added to the base system to increase functionality, such as audio, networking, graphics, SCSI controller, and so on. Add-on devices fall into two categories: devices built onto the system board and devices on expansion cards added to the system through a system board connector such as PCI.

ADSL Asymmetric Digital Subscriber Line. A method for moving data over regular phone lines. An ADSL circuit is much faster than a regular phone connection, and the wires coming into the subscriber's premises are the same (copper) wires used for regular phone service.

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API Application programming interface. A set of routines that an applications program uses to request and carry out lower-level services performed by a computer operating system.

architecture A general term referring to the structure of all or part of a computer system. Also covers the design of system software, such as the operating system, as well as referring to the combination of hardware and basic software that links machines on a computer network.

ATA AT Attachment. An integrated bus usually used between host processors and disk drives. Used interchangeably with IDE.

ATAPI ATA Packet Interface. A hardware and software specification that documents the interface between a host computer and CD-ROM drives using the ATA bus.

ATM Asynchronous transfer mode. A transmission protocol that segments user traffic into small, fixed-size units called cells, which are transmitted to their destination, where they are reassembled into the original traffic. During transmission, cells from different users may be intermixed asynchronously to maximize utilization of network resources.

B

bandwidth Usually used in reference to the amount of data per unit of time that must move from one point to another, such as from CD-ROM to processor.

BIOS Basic I/O system. A set of routines that works closely with the hardware to support the transfer of information between elements of the system, such as memory, disks, and the monitor. Although critical to performance, the BIOS is usually invisible to the end user; however, programmers can access it.

bps Bits per second. The number of bits transferred per second in a data communications system. A measure of speed.

bus enumerator In a Plug and Play system, a bus device driver that detects devices located on a specific bus and loads information about devices into the hardware tree.

C

cache A special memory subsystem in which frequently used data values are duplicated for quick access.

CD-ROM Compact disc read-only memory. A 4.75-inch laser-encoded optical memory storage medium (developed by NV Philips and Sony Corporation) with the same constant linear velocity (CLV) spiral format as compact audio discs and some video discs. CD-ROM discs can hold about 550 MB of data.

CI Component Instrumentation. A specification for DMI related to the service layer.

class For hardware, the manner in which devices and buses are grouped for purposes of installing and managing device drivers and allocating resources.

class driver A driver that provides system-required, hardware-independent support for a given class of physical devices. Such a driver communicates with a corresponding hardware-dependent port driver, using a set of system-defined device control requests, possibly with additional driver-defined device control requests. Under WDM, the class driver is responsible for multiprocessor and interrupt synchronization.

COM 1. Component Object Model; the core of OLE. Defines how OLE objects and their clients interact within processes or across process boundaries. 2. Legacy serial port.

CPU Central processing unit. A computational and control unit of a computer; the device that interprets and executes instructions. By definition, the CPU is the chip that functions as the “brain” of the computer.

D

data rate The speed of a data transfer process, normally expressed in bits per second or bytes per second.

DDC Display data channel. The Plug and Play baseline for monitors. The communications channel between a monitor and the display adapter to which it is connected. This channel provides a method for the monitor to convey its identity to the display adapter.

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device Any circuit that performs a specific function, such as a parallel port.

device ID A unique ASCII string for a device created by enumerators to identify a hardware device and used to cross-reference data about the device stored in the registry. Distinguishes each logical device and bus from all others on the system.

disk I/O controller *Also* HDC. A special-purpose chip and circuitry that directs and controls reading from and writing to a computer's disk drive.

DLL Dynamic link library. API routines that User-mode applications access through ordinary procedure calls. The code for the API routine is not included in the user's executable image. Instead, the operating system automatically points the executable image to the DLL procedures at run time.

DMA Direct memory access. A method of moving data from a device to memory (or vice versa) without the help of the microprocessor. The system board uses a DMA controller to handle a fixed number of channels, each of which can be used by only one device at a time.

DMI Desktop Management Interface. A framework created by the DMTF. DMTF specifications define industry-standard interfaces for instrumentation providers and management applications.

driver Kernel-mode code used either to control or emulate a hardware device.

driver stack Device objects that forward IRPs to other device objects. Stacking always occurs from the bottom up and is torn down from the top.

DVD Optical disk storage that encompasses audio, video, and computer data.

E

ECP Extended capabilities port. An asynchronous, 8-bit–wide parallel channel defined by IEEE 1284–1944 that provides PC-to-peripheral and peripheral-to-PC data transfers.

EISA Extended Industry Standard Architecture. A 32-bit expansion bus designed as a superset of the ISA bus. Designed to expand the speed and data width of the legacy expansion bus while still supporting older ISA cards.

enumerator A Plug and Play device driver that detects devices below its own device node, creates unique device IDs, and reports to Configuration Manager during startup. For example, a SCSI adapter provides a SCSI enumerator that detects devices on the SCSI bus.

expansion bus A group of control lines that provide a buffered interface to devices located either on the system board or on cards that are plugged into expansion connectors. Common expansion buses included on the system board are USB, PC Card, and PCI.

expansion card A card that connects to an expansion bus and contains one or more devices.

expansion ROM *See* option ROM.

F

FDC Floppy disk controller. A chip and associated circuitry that directs and controls reading from and writing to a computer's disk drive.

FIFO First in/first out. A method for processing a queue in which items are removed in the same order they were added.

filters 1. Components that provide the basic building blocks for processing data. 2. Under the WDM Stream architecture filters are also known as a functional device or multimedia processing driver. Each filter's capability is described in part by connection points called pins. Each pin can consume and produce a data stream, such as digital audio. Specialized tasks can be solved by connecting filters through their pins into a topology, for example, to play filtered and mixed audio. 3. Under WDM, a filter is implemented as a kernel-mode entity—a device object usually implemented by a kernel driver. 4. Under ActiveMovie, a filter is a User-mode entity that is an instance of a COM object, usually implemented by a DLL.

full duplex In terms of data flow, indicates bi-directional data flow.

H

HCI Host controller interface, such as the system-level interface supporting USB.

HCL Hardware Compatibility List. *See* WHQL.

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HCT Hardware Compatibility Tests. A suite of tests from WHQL to verify hardware and device driver operations under a specific operating environment. These tests exercise the combination of a device, a software driver, and an operating system under controlled conditions to verify that all components operate properly.

I

IDE Integrated Device Electronics. A type of disk-drive interface where the controller electronics reside on the drive itself, eliminating the need for a separate adapter card.

IEEE Institute of Electrical and Electronics Engineers. Organization that develops standards.

INF file Information file. A file created for a particular adapter that provides the operating system with information required to set up a device, such as a list of valid logical configurations for the device, the names of driver files associated with the device, and so on. An INF file is typically provided by the device manufacturer on a disk with an adapter.

INI file Initialization file. Commonly used under Windows 3.*x* and earlier, INI files have been used by both the operating system and individual applications to store persistent settings related to an application, driver, or piece of hardware. In Windows NT and Windows 95, INI files are supported for backward compatibility, but the registry is the preferred location for storing such settings.

input class The class of filters that provides an interface for HID hardware, including USB and legacy devices, plus proprietary and other HID hardware, under the WDM HID architecture.

instrumentation A mechanism for reporting information about the state of hardware and software to enable management applications to ascertain and change the state of a system and to be notified of state changes.

integrated device Any device—such as a parallel port or graphics adapter—that is designed on the system board rather than on an expansion card.

interface For parameters on a connection request, a specific set of methods and properties implemented on a medium that a filter connection uses to communicate, such as a specific set of IOCTLs.

I/O Input/output. Two of the three activities that characterize a computer (input, processing, and output). Refers to the complementary tasks of gathering data for the microprocessor to work with and make the results available to the user through a device such as the display, disk drive, or printer.

IOCTL Input/output control. A custom class of IRPs available to User mode. Each WDM class driver has a set of IOCTLs that it uses to communicate with applications. The IOCTLs give the class driver information about intended usage by applications. The class driver performs all IOCTL parameter validation.

IPL Initial program load. A device used by the system during the boot process to load an operating system into memory.

IRP I/O request packet. Data structures that drivers use to communicate with each other. The basic method of communication between kernel-mode devices. An IRP is a key data structure for WDM, which features multiple layered drivers. In WDM, every I/O request is represented by an IRP that is passed from one driver layer to another until the request is complete. When a driver receives an IRP, it performs the operation the IRP specifies, and then either passes the IRP back to the I/O Manager for disposal or onto an adjacent driver layer. An IRP packet consists of two parts: a header and the I/O stack locations.

IRQ Interrupt request. A method by which a device can request to be serviced by the device's software driver. The system board uses a PIC to monitor the priority of the requests from all devices. When a request occurs, a microprocessor suspends the current operation and gives control to the device driver associated with the interrupt number issued. The lower the number—for example, IRQ3—the higher the priority of the interrupt. Many devices only support raising requests of specific numbers.

ISA Industry Standard Architecture. An 8-bit (and later, a 16-bit) expansion bus that provides a buffered interface from devices on expansion cards to the internal bus.

ISDN Integrated Service Digital Network. A set of communications standards that enable a single phone line or optical cable to carry voice, digital network services, and video.

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isochronous Refers to a communication protocol based on time slices rather than handshaking. For example, a process might have 20 percent of total bus bandwidth. During its time slice, the process can stream data.

K

kernel The core of the layered architecture that manages the most basic operations of the operating system, such as sharing the processor between different blocks of executing code, handling hardware exceptions, and other hardware-dependent functions.

kernel mode The processor mode that allows full, unprotected access to the system. A driver or thread running in kernel mode has access to system memory and hardware.

kernel-mode driver Driver for a logical, virtual, or physical devices.

L

LAN Local area network. A group of computers and other devices dispersed over a relatively limited area and connected by a communications link that enables any device to interact with any other device on the network. *Compare with* WAN.

layered driver One of a collection of drivers that responds to the same IRPs. Layered driver describes the highest- and lowest-level drivers in a chain of layered drivers that process the same IRPs, along with all intermediate drivers in the chain.

legacy Any feature in the system based on older technology for which compatibility continues to be maintained in other system components.

local bus Usually refers to a system bus directly connected to the microprocessors on a system board. Used colloquially to refer to system board buses that are located closer to the microprocessor than expansion buses (that is, with less buffering), which are therefore capable of greater throughput.

M

MDL Memory descriptor list. In Windows NT, an opaque structure, defined by Memory Manager, that uses an array of physical page frame numbers to describe the pages that back a virtual memory range.

minidriver A hardware-specific DLL that uses a Microsoft-provided class driver to accomplish most actions through functions call and provides only device-specific controls. Under WDM, the minidriver uses the class driver's device object to make system calls.

miniport driver A device-specific kernel-mode driver linked to a Windows NT or WDM port driver, usually implemented as a DLL that provides an interface between the port driver and the system.

monolithic driver A driver that has many different classes of functionality contained in the same driver.

motherboard *See* system board.

multifunction device A piece of hardware that supports multiple, discrete functions, such as audio, mixer, and music, on a single adapter.

N

NDIS Network Driver Interface Specification. The interface for network drivers used in Windows NT and Windows. NDIS provides transport independence for network vendors because all transport drivers call the NDIS interface to access the network.

nibble mode An asynchronous, peripheral-to-host channel defined in the IEEE 1284-1944 standard. Provides a channel for the peripheral to send data to the host, which is commonly used as a means of identifying the peripheral.

NMI Nonmaskable Interrupt. An interrupt that cannot be overruled by another service request. A hardware interrupt is called nonmaskable if it cannot be masked by the processor's interrupt enable flag.

NTFS Windows NT file system. An advanced file system designed for use specifically with the Windows NT operating system. NTFS supports file system recovery and extremely large storage media, in addition to other advantages.

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O

OEM Original equipment manufacturer. Used primarily to refer to systems manufacturers.

OnNow A design initiative that seeks to create all the components required for a comprehensive, system-wide approach to system and device power control. OnNow is a term for a system that is always on but appears off and that responds immediately to user or other requests.

option ROM Optional read-only memory found on an expansion card. Option ROMs usually contain additional firmware required to properly boot the peripheral connected to the expansion card, for example, a hard drive.

P

PCI Peripheral Component Interconnect. A 32-bit or 64-bit bus designed to be used with devices that have high bandwidth requirements, such as the display subsystem.

planar *See* system board.

Plug and Play A design philosophy and set of specifications that describe hardware and software changes to the system and its peripherals that automatically identify and arbitrate resource requirements among all devices and buses on the system. Plug and Play specifies a set of device driver interface elements that are used in addition to, not in place of, existing driver architectures.

port A connection or socket used to connect a device—such as a printer, monitor, or modem—to the computer. Information is sent from the computer to the device through a cable.

port driver A low-level driver that responds to a set of system-defined device control requests and possibly to an additional set of driver-defined (private) device control requests sent down by a corresponding class driver. A port driver insulates class drivers from the specifics of host bus adapters and synchronizes operations for all its class drivers.

port replicator Low-cost docking-station substitute intended to provide convenient, one-step connection to multiple desktop devices.

POST Power-on self-test. A procedure of the system BIOS that identifies, tests, and configures the system in preparation for loading the operating system.

power management Mechanisms in software and hardware to minimize system power consumption, manage system thermal limits, and maximize system battery life. Power management involves trade-offs among system speed, noise, battery life, processing speed, and power consumption.

Q

QIC Quarter-Inch Cartridge Drive Standards, Inc. An international trade association dedicated to promoting use of quarter-inch tape technology and products. For more information, visit the web site at http://www.qic.org/.

R

RAM Random access memory**.** Semiconductor-based memory that can be read and written by the microprocessor or other hardware devices. Refers to volatile memory, which can be written as well as read.

real-time processing Processing that supports real-time functions such as telephony.

registry In Windows NT and Windows, the tree-structured hierarchical database where general system hardware and software settings are stored. The registry supersedes the use of separate INI files for all system components and applications that know how to store values in the registry.

resource 1. A set from which a subset can be allocated for use by a client, such as memory or bus bandwidth. This is not the same as resources that are allocated by Plug and Play. 2. A general term that refers to IRQ signals, DMA channels, I/O port addresses, and memory addresses for Plug and Play.

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RISC Reduced instruction set computing. A type of microprocessor design that focuses on rapid and efficient processing of a relatively small set of instructions. RISC architecture limits the number of instructions that are built into the microprocessor, but optimizes each so it can be carried out very rapidly—usually within a single clock cycle.

RISC-based Refers to computers based on Windows NT-compatible implementations of RISC processors (specifically DEC Alpha).

rt Real time. In computing, refers to an operating mode under which data is received and processed; the results are returned instantaneously.

S

scalability 1. Ability of a system to take advantage of multiple processors. 2. The ability to vary the information content of a program by changing the amount of data that is stored, transmitted, or displayed. 3. In a video image, this translates to creating larger or smaller windows of video on screen (shrinking effect).

SCSI Small computer system interface. *Pronounced* "scuzzy." An I/O bus designed as a method for connecting several classes of peripherals to a host system without requiring modifications to generic hardware and software.

smart card A small electronic device about the size of a credit card that contains an embedded integrated circuit. Smart cards are used for a variety of purposes, including storing medical records, storing digital cash, and generating network IDs.

software device A filter in kernel streaming and ActiveMovie that has no underlying hardware associated with it.

spin down A power-management capability in which a hard drive shuts down its spindle motor.

static resources Device resources, such as IRQ signals, DMA channels, I/O port addresses, and memory addresses, that cannot be configured or relocated.

stream An object representing an entity on an adapter capable of receiving, processing, or supplying data. Notice that a stream is identical to a WDM Stream architecture pin. A stream can accept data from or supply data to the processor, such as a stream representing an MPEG input, or can simply route data through hardware, such as a stream representing an NTSC output jack on the back of an adapter. The purpose of representing non-data hardware with a stream is that the properties of the hardware can be controlled by software.

SVGA Super VGA. A video standard established by VESA to provide high-resolution color display on IBM-compatible computers.

system board *Also* motherboard *or* planar. The primary circuit board in a system that contains most of the basic components of the system.

system devices Devices on the system board, such as interrupt controllers, keyboard controller, real-time clock, DMA page registers, DMA controllers, memory controllers, FDC, ATA ports, serial and parallel ports, PCI bridges, and so on. In today's systems, these devices are typically integrated in the supporting chip set.

T

TAPI Telephony Application Program Interface. A set of Win32-based calls that applications use to control modems and telephones by routing application function calls to the appropriate service provider DLL for a modem.

TCP/IP Transport control protocol/interface program. A software protocol developed by the Department of Defense for communications between computers.

telephony Telephone technology.

U

UART Universal Asynchronous Receiver/Transmitter. A module composed of a circuit that contains both the receiving and transmitting circuits required for asynchronous serial communication.

Unimodem Universal modem driver. A driver-level component that uses modem description files to control its interaction with the communications driver, VCOMM.

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UPS Uninterruptible power supply. A device connected between a computer and a power source that ensures that electrical flow to the computer is not interrupted because of a blackout and, in most cases, protects the computer against potentially damaging events such as power surges and brownouts.

USB Universal Serial Bus. A bi-directional, isochronous, dynamically attachable serial interface for adding peripheral devices such as game controllers, serial and parallel ports, and input devices on a single bus.

USB class The class of filters under WDM that provides a bus interface and bus enumerator for USB.

user mode The nonprivileged processor mode in which application code executes, including protected subsystem code in Windows NT.

user-mode drivers Win32-based multimedia drivers and VDDs for MS-DOS–based applications with application-dedicated devices. For information, see the *Multimedia Drivers* and *Virtual DOS Drivers* documentation in the Windows NT DDK.

V

VAR Value added reseller. A company that resells hardware and software packages to developers and/or end users.

VESA Video Electronics Standards Association. A governing body that establishes standards for the video and graphics portions of the electronics industry.

W

WAN Wide area network. A communications network that connects geographically separated areas. *Compare with* LAN.

WBEM Web-based Enterprise Management. A DMTF initiative to provide a standards-based mechanism to specify information exchange between management applications and managed components. This work was recently transferred to the DMTF by BMC Software, Inc., Cisco Systems, Inc., Compaq Computer Corporation, Intel Corporation, and Microsoft Corporation.

WDL Windows NT Driver Library. *See* WHQL.

WDM Windows Driver Model. A 32-bit driver model based on the Windows NT driver model that is designed to provide a common architecture of I/O services and binary-compatible device drivers for both Windows NT and Windows operating systems for specific classes of drivers. These driver classes include USB and IEEE 1394 buses, audio, still-image capture, video capture, and HID-compliant devices such as USB mice, keyboards, and joysticks. Provides a model for writing kernel-mode drivers and minidrivers, and provides extensions for Plug and Play and power management.

WHQL Windows Hardware Quality Labs. Provides testing services for hardware and drivers for Windows and Windows NT. Administers testing for the “Designed for Microsoft Windows” logo programs. See http://www.microsoft.com/hwtest/.

Win32 API A 32-bit application programming interface for both Windows and Windows NT that includes sophisticated operating system capabilities, security, and API routines for Windows-based applications.

Windows Management Instrumentation Extensions to WDM developed for Windows NT 5.0 and Windows to provide an operating system interface through which instrumented components can provide information and notifications.

Windows NT The Microsoft Windows NT version 5.0 operating system, including any add-on capabilities and later versions of the operating system.

Windows NT DDK Supports Windows NT, provided through MSDN Professional membership. Documents the Windows NT driver model (upon which WDM is based) and is an essential component for building WDM drivers.

Z

Zero Administration for Windows An initiative that focuses on improving Windows and Windows NT for maximum automation of administrative tasks with centralized control and maximum flexibility.

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